BUILDING STONES OF KENTUCKY

CHARLES HENRY RICHARDSON

The Kentucky Geological Survey

WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST

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Building Stones of Kentucky

1923

"KENTUCKY'S WHITE HOUSE"

The mansion of the Governor of Kentucky viewed from the west cliffside of the Kentucky River at Frankfort. Bowling Green oolitic limestone was used in its exterior construction with pleasing effect.

The
BUILDING STONES *of* KENTUCKY

A Detailed Report Covering the Examination, Analysis
and Industrial Evaluation of the Principal
Building Stone Deposits
of the State

BY
CHARLES HENRY RICHARDSON
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Author of
ECONOMIC GEOLOGY
BUILDING STONES AND CLAYS
GLASS SANDS OF KENTUCKY, *Etc.*

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Letter of Transmission

DR. WILLARD ROUSE JILLSON,
DIRECTOR AND STATE GEOLOGIST,
THE KENTUCKY GEOLOGICAL SURVEY,
FRANKFORT, KENTUCKY.

Dear Sir:

Permit me to transmit herewith my illustrated manuscript entitled, the Building Stones of Kentucky.

The field work for the preparation of this report was done during the summers of 1921 and 1922. The time at my disposal proved inadequate to cover the entire state. However, more than one hundred of the one hundred and twenty counties of the state were visited, and their building stone possibilities are described herein.

It is hoped that the report will contribute somewhat to the literature of the country on building stones and prove of service not only to the people of the state of Kentucky, but also to quarrymen and manufacturers of building stone elsewhere in the commercial development of the building stone deposits of this state.

Respectfully submitted,
CHARLES H. RICHARDSON,
Assistant Geologist.

Frankfort, Ky.,
Aug. 24, 1922.

Author's Preface

The object in preparing this report upon the building stones of Kentucky is mainly to present to the general public through libraries, boards of trade, chambers of commerce, manufacturers of building stones, architects, engineers and contractors, unfamiliar with the building stone resources of Kentucky, some information of general interest and value upon the building stone possibilities of the state.

It seemed advisable to take up the study of this problem of investigation because there was no definite report dealing directly with the building stones of Kentucky, no samples so far as known had been polished to show the adaptability of the building stones for decorative and interior work, and no microscopic slides had ever been made to ascertain the optical properties of the essential minerals and to detect objectionable accessory constituents.

In connection with this work the author visited most of the quarries in more than one hundred of the one hundred and twenty counties of the state. In selection no discrimination was made between the quarries capable of producing structural stone and those used only in the preparation of road building material. Much valuable material was incidentally collected which it is hoped may later find expression in a report upon the road building rocks of Kentucky.

Several hundred photographs were taken in the field. With but a few exceptions where credit has been given all photographs which appear as half-tone illustrations in this work were taken by the author personally. About one hundred and eighty rock samples were collected, trimmed three by four inches, labeled and placed on exhibition in the museum of the Kentucky Geological Survey. Approximately twenty-five samples trimmed three by four inches have been polished to show the susceptibility of the stone to polish and its value for decorative interior work.

Fifteen microscopic slides have been made about one-thousandth of a millimeter in thickness for study under polarized light. By this investigation the texture of the building stones, their mineralogical composition and their life history may be the better understood.

The author recognizes his especial indebtedness to Dr. Willard Rouse Jillson, State Geologist, for his many suggestions and hearty co-operation; to Dr. Alfred M. Peter, of the Experiment Station, Lexington, Ky., for the large number of chemical analyses which accompany this report; to Prof. Arthur M. Miller, Professor of Geology at the University of Kentucky, Lexington, Ky., for his kindly assistance in locating quarries and his many helpful suggestions; to the many superintendents of quarries and to the county road engineers for their respective courtesies and timely assistance, and to all others who in any measure have aided in the preparation of this work.

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CHAPTER I.

INTRODUCTION

A small part of the field work upon which this report is based was done during the summer of 1920 in conjunction with the author's work on the Glass Sands of Kentucky. However, most of the work was done during the months of June, July, August and September, 1921. It was completed during the summer of 1922. The best known localities for the occurrence of building stones were first visited, and then a systematic visitation was made of the various quarries in all counties traversed by railroads and some counties that the railroads do not enter. Over one hundred of the one hundred and twenty counties of the State were visited. The time at the author's disposal was inadequate to visit a few counties remote from railroads, and for this reason it is known that some isolated quarries have not been listed or examined.

The State of Kentucky naturally divides itself into five distinct districts for investigation and description of its building stones. These may be listed as follows: (1) Eastern Kentucky, including the Knobs. (2) Central Kentucky, or the Bluegrass Section. (3) The Mississippian Outcrops, or central, southern and western Kentucky. (4) The Western Coal Fields. (5) The Jackson Purchase. In the description of the building stones of the State this order will be followed.

The above mentioned sections were studied to ascertain the approximate area of the different terranes involved, to determine their relative thickness and their mineral composition, both essential and accessory, their susceptibility to a polish and their value for constructional, inscriptional and decorative work.

Two samples were collected from most of the quarries visited and sent to Frankfort. One sample can be seen in the Museum of the Kentucky Geological Survey. The other is intended for exhibition in the State Historical Museum. Several smaller samples were collected for chemical and microscopic analysis. Dr. Arthur M. Peter, State Agricultural Experiment Station, Lexington, Kentucky, who has long been engaged in chemical investigations, had previously analyzed a large number of rock samples from the State. Many of these results will

appear in the subsequent portions of this work. Several microscopic slides have been made, and the optical mineralogy and petrography of the rocks studied in the author's laboratory at Syracuse University, Syracuse, N. Y., will throw some new light on the early geologic history of the State.

A large number of photographs of buildings in Kentucky were taken to accompany this work. These represent stone structures such as libraries, courthouses, postoffices, banks, churches, business blocks, outside chimneys, retaining walls, foundations, etc. Views of quarries showing their size, the various methods of quarrying, and the thickness of the individual beds of building stones, are also shown. Attention has been given to the means and cost of transportation from given quarries to the nearest railroad station, and to the possibilities of shipping the stone beyond the borders of the State.

The above investigations have led to the conclusion that the building stones of Kentucky naturally fall into three classes: (1) Limestones. (2) Marbles. (3) Sandstones. They may also be classified from a different viewpoint, as: (1) Those adapted to local consumption only. (2) Those well suited for constructional work within the borders of the State. (3) Those that by their color, texture and purity have already won, or may win, a national reputation. The widest reputation gained thus far by any building stone within the State belongs to the Bowling Green oolitic limestone which in many ways resembles the Bedford, Indiana, oolitic limestone that is justly popular as a constructional stone.

It was hoped that adequate time would be given for a detailed petrographic study of all of the building stones within the State, but a miscroscopic investigation under polarized light of samples from all the quarries visited would require a much longer period of time than could be allotted to this work.

A carefully prepared bibliography, showing it is believed the more important publications relating to building stones in general and especially those of Kentucky, accompanies this report.

CHAPTER II.

MINERALS OF BUILDING STONES

The term building stones as here used embraces all those forms of igneous, sedimentary and metamorphic rocks that are utilized for structural or decorative purposes, whether that use is large, like the oolitic limestones of Bowling Green, Kentucky, or small, like the ophicalcites, which consist of a mixture of serpentine with calcite.

The igneous rocks are sparingly present in Kentucky. A sample of granite reported to have come from Black Mountain in the southeastern part of the State is preserved in the collection of the Kentucky Geological Survey at Frankfort. But this igneous rock is certainly not indigenous to that region. Like many another odd rock specimen, it has been transported from elsewhere. Granites are not known to occur in Kentucky.

There are, however, peridotite dikes of igneous origin in Elliott and Lawrence Counties in the eastern part of the State, and in Caldwell, Crittenden and Livingston Counties in the western part of the State. Most of these dikes are very narrow and much altered or decomposed near the surface. The Kimberlite dikes of Elliott County have furnished the freshest samples of any seen by the author from the peridotite group of rocks in Kentucky.

In the discussion which follows an attempt has been made to give the reader some of the more salient geological and mineralogical features, both natural and aritficial, to enable the architect and engineer by simple tests to determine what objectional constituents, if any, are present and thereby select wisely material that will last well and be harmonious in its environment. Furthermore an effort is made to show that excellent building stones are more widely distributed and of more varied types within the State than was formerly supposed.

Minerals of Building Stones

Definition. A mineral is an inorganic substance occurring in nature with a fairly definite chemical composition. It usually possesses a definite crystalline structure which sometimes finds expression in external geometrical forms or outlines.

The result of certain processes carried out in the laboratory is the production of salts with the same chemical composition as the corresponding minerals. These artificial products are not minerals for they were not formed in the laboratory of nature.

A rock is any mineral or mineral aggregate that forms an essential part of the earth. To be a geological formation it must represent a mapable area. The igneous rocks may occur either as eruptives that have flowed out over the surface of older formations, or as irruptives in stocks, sheets, dikes, etc., that appear at the surface only through continental denudation. As already noted, the igneous rocks are of very limited occurrence in Kentucky.

The sedimentary rocks occur in stratified beds. In some instances the planes of stratification are lost. Almost all of the rocks of Kentucky are of sedimentary origin.

Number. The number of minerals necessary in the formation of a given type of building stone is exceedingly small. Calcite is the only mineral necessary in statutary marble. Analyzed samples of this marble from western Vermont have given 99.5 per cent calcite and .5 per cent silica. A sandstone may consist of little more than grains of quartz held together by the pressure to which they have been subjected. A true syenite requires but two minerals, orthoclase and hornblende. A granite demands the presence of quartz and orthoclase; and usually some ferromagnesian mineral is present, as biotite or hornblende.

A miscroscopic examination of building stones usually adds a few minor minerals to the requisite number for a given type of rock. These are of importance in the weathering of a stone, but not necessary in its commercial definition.

Classification. The minerals of building stones are classified as essential and accessory, or as original and secondary. The essential minerals determine the definition of a given type of rock. Quartz is essential in a sandstone, quartz and orthoclase in a granite. An accessory mineral is one that is usually present but of minor importance. Its presence may be recognized microscopically or macroscopically. For example, apatite or magnetite may occur in a granite.

An original mineral as applied to the necessary constituents of building stones is one that was present when solidification first occurred. It is always an essential mineral. Apatite and zircon when present in granites are among the first minerals to solidify from an acid magma yet they are not essential to the commercial definition of a granite. A secondary mineral is one that is derived from some other mineral or minerals either by the chemical action of percolating waters or by molecular rearrangement. Olivine is an essential mineral in peridotite while serpentine results from the loss of the iron and the hydration of the magnesium in olivine.

In order to best understand the nature of structural stones some knowledge of mineralogy is necessary. Even a descriptive elementary method of treating minerals has some value. It would not seem advisable to enter into detail to any considerable extent for most minerals may be recognized by a few simple tests. These will enable an architect or engineer to arrive easily at his definition of a given type of structural stone.

Essential. The number of minerals occurring as essential constituents in building stones is exceedingly small. The list may be summed up in the various varieties of quartz; four families, the feldspars, micas, amphiboles, pyroxenes; three anhydrous silicates, olivine, epidote, nephelite, or the variety eleolite; three hydrous silicates, talc, serpentine, chlorite; three carbonates, calcite, aragonite, dolomite; and one sulphate, gypsum.

Non-essential. The non-essential minerals are vastly greater in number but they occur in small proportions and often of microscopic size. The presence of some of these is exceedingly deleterious while others are harmless. These may be summed up in two elements, four sulphides, two carbonates, seven oxides, one phosphate, one chloride, one fluoride, together with several anhydrous and hydrous silicates. A brief statement concerning the more important of these minerals will suffice.

Description of Minerals

The following description of minerals is taken bodily from the author's textbook on Building Stones and Clays, pp. 3-14 inclusive: (All rights reserved.)

Quartz. Quartz is an oxide of silicon, SiO_2. It is 7 in the scale of hardness, 2.65 in specific gravity, vitreous in luster, insoluble in the common mineral acids. It can easily be recognized by its insolubility, its luster and superior hardness to all other essential minerals in building stones. It is one of the most widely distributed of all minerals. It composes most of the sands of the seashore and river plains. It is essential in all sandstones and mica schists. It is present in all granites, gneisses, quartzites, liparites, etc. The quartz grains in fragmental sandstones have sometimes undergone a secondary growth by a deposition of crystallized silica with like orientation to the original nucleus.

Quartz is furthermore one of the most indestructable of minerals for there is no higher oxide of silicon. The fluid cavities sometimes found in quartz cause the rock mass rich in silica to scale after being subjected to the heat of a burning building.

The Feldspars. The term feldspar is a family name embracing a group of minerals with many characteristics in common. They are silicates of aluminum with either potassium, sodium, or calcium present, while magnesium and iron are always absent. There are many intermediate species between the sodium and calcium members which are connected with each other by insensible gradations. Some of the common characteristics of the family are as follows: (1) Crystallization in the monoclinic or triclinic systems with a close resemblance among the different species in general habit, cleavage angle and method of twinning. (2) Colors shading from white to green or red. (3) Hardness falling between 6 and 6.5. (4) Specific gravity generally between 2.5 and 2.75.

Orthoclase, K_2O, Al_2O_3, $6SiO_2$, is an acid feldspar occurring as an essential constituent in all granites, most gneisses and true syenites. It is easily recognized by a possible cleavage angle of 90 degrees and the absence of striations on all cleavage planes. It fuses at 5 and is insoluble in mineral acids.

Microline crystallizes in the triclinic system. Its chemical composition is the same as that of orthoclase, K_2O, Al_2O_3, $6SiO_2$. It often shows a peculiar shade of green which aids in distinguishing the crystals from those of the other feldspars. In case

of the building stones it often requires a microscopic examination to establish the difference. Its home is with the acid and intermediate irruptives.

Plagioclase is the term often given to designate the remaining members of the feldspar family all of which are triclinic in system of crystalization. They are albite, oligoclase, andesine, labradorite and anorthite.

Albite, as the name implies, is usually white in color. Its formula is Na_2O, Al_2O_3, $6SiO_2$. It fuses at 4 and is insoluble in mineral acids. It occurs in many granites along with orthoclase and is usually distinguishable by its greater whiteness. In some highly colored granites the few white crystals present are albite. When it occurs as the essential feldspar with hornblende it constitutes a diorite.

Oligoclase is intermediate in composition between albite and anorthite. It fuses at 3.5 to an enamel-like glass and is imperfectly acted upon by mineral acids. It is often recognized by fine striations or parallel lines on some cleavage plane. Its home is with both the irruptives and the eruptives.

Andesine is also intermediate between albite and anorthite. It fuses in thin splinters before the blowpipe and is imperfectly soluble in mineral acids. Its color is usually white or gray. It gives definition to the rock called andesite. It occurs in some syenites and porphyries.

Labradorite is more basic than the preceding feldspar. It fuses at 3 to a colorless glass and is partially soluble in HCl. It shades in color from gray to green and often presents a beautiful iridescence, especially when polished, in which blue and green are predominant colors, but yellow and fire-red colors also occur. It is often finely striated upon the cleavage planes. It occurs with hypersthene in the building stone known as norite. Its home is also with gabbros, diabases and dolerites.

Anorthite is the most basic member of the feldspar family. Its formula is CaO, Al_2O_3, $2SiO_2$. It fuses at 5 to a colorless glass and is soluble in HCl with a separation of gelatinous silica. In color it shades from white to red. Its home is with the basic intrusives. Some of the New England diabases bearing anorthite constitute the finest road metal.

It is important before selecting any granite for a massive structure to examine carefully microscopic slides of the stone. If the feldspar has already suffered kaolinization the rock should be rejected. The microscope often reveals cavities and flaws so filled with impurities and products of decomposition as to render the feldspar quite opaque. Such a building stone will not long withstand the destructive effects of weathering agencies.

The color often imparted to granites, gneisses and quartz porphyries is due to the color of the prevailing feldspar. In the red granites the pigment in the feldspar is ferric iron. In the green granites it has been attributed to ferrous iron and in the delicately pink granites to manganese.

The Micas. The mica family includes a series of closely related minerals characterized by a highly perfect basal cleavage. They are easily separable into plates varying in thickness from one thousandth to one fifteen hundreth of an inch in thickness. They all fall in the monoclinic system.

Muscovite, chemically considered, is an orthosilicate of aluminum, potassium and hydrogen. It is known also as the potassium mica or the white mica. In some light colored granites it is practically the only mica present. This holds especially true of the white granite of Bethel, Vermont. The thin laminae of muscovite are flexible and spring back with considerable force into normal position when bent. Its hardness is 2.3. Its gravity is 2.9. Muscovite is inslouble in the mineral acids, and when it bears no iron it possesses greater powers of endurance than the other members of the mica family.

Biotite is also an orthosilicate of aluminum, potassium, hydrogen, magnesium and iron. It is known as the iron mica and the black mica. The presence of iron favors decomposition for when the mineral is once coated with a thin film of the oxide of iron it is rapidly disintegrated. Biotite is 2.8 in hardness and sometimes reaches a specific gravity of 3. The presence of large quantities of biotite in a granite increases the weight per cubic foot, and decreases the life of the stone. The finely pulverized mineral is decomposed by sulphuric acid with a separation of the silica in minute scales.

Phlogopite is closely related to biotite in composition, but carries less iron. It is known as the magnesium mica, or amber

mica, on account of its amber-like reflections. It often exhibits asterism in transmitted light. Its hardness is 2.7 and its specific gravity 2.8. It is completely decomposed by sulphuric acid with a separation of the silica in minute scales. The home of phlogopite is with the marbles and serpentines in which it often becomes an objectionable constituent.

Lepidomelane is in part an orthosilicate and in part a more basic compound. It is chiefly characterized by a large amount of ferric iron. It is best regarded as a variety of biotite.

The presence of the various micas in limestones, dolomites and marbles may be regarded as objectionable for they are difficult to polish and scale off easily, leaving the stone pitted. In such rocks the micas are of secondary origin. In the granites and gneisses the micas are of primary origin. They should be uniformly scattered throughout the stone in fine scales, for with their perfect cleavage they themselves constitute an element of weakness. When in spherical aggregations as in the granite of Craftsbury, Vermont, they give rise to the orbicular granites.

The Amphiboles. The amphibole family includes a group of minerals that crystalize in the orthorhombic, monoclinic and triclinic systems. Those occurring in building stones fall in the monoclinic system and the representatives are tremolite, actinolite and hornblende.

Tremolite is a silicate of calcium and magnesium. Hardness of 5.5 and specific gravity of 3. It sometimes appears as short, stout prisms, and sometimes columnar, or fibrous. It is an objectionable constituent as a secondary mineral in marbles, for the stone becomes pitted through the loss of lime and the falling out of the minute crystals of tremolite. Furthermore, the mineral often changes color from a pure white when quarried to a dirty gray upon exposure to the atmosphere.

Actinolite is closely related to tremolite in composition, but has a little of the magnesium replaced by iron which imparts bright green or grayish color to the mineral. Hardness of 5.5 and gravity of 3.1. The crystals are short, bladed, columnar and fibrous. Its home is with the metamorphics.

Hornblende is an aluminous variety of amphibole. Hardness 5.5 to 6. Specific gravity 3.2. Its color is often greenish

black to black. It is an essential constituent in certain granites like the granite of Quincy, Mass., gneisses, schists and diorites. The crystals are often long and prismatic. The mineral may easily be identified by its black color and cleavage angles of 56 and 124 degrees. The cleavage is far more pronounced than it is in the pyroxenes.

The Pyroxenes. The pyroxene family embraces a number of species that fall in the orthorhombic, monoclinic and triclinic systems of crystallization. The metasilicates of calcium, magnesium and iron are the most prominent members of the groups. They all present a fundamental prismatic form with an angle of 87 or 93 degrees parallel with which there is a pronounced prismatic cleavage.

Enstatite is a metasilicate of magnesium, MgO, SiO_2. Its hardness is 5.5 and specific gravity 3.2. In color it is often gray, but when iron displaces a part of the magnesium the mineral is bronze-like in color. Its home is in the peridotites and the serpentines derived from them. In its hydration talc is the metamorphic product.

Hypersthene, (Fe,Mg)O, SiO_2. Hardness 5.5. Specific gravity 3.4. In color the mineral shades from a dark brownish green to a greenish black. Hypersthene is an essential constituent of certain so-called granites like the Keeseville, N. Y., norite. It is also found in some gabbros and andesites. It sometimes produces black knots in the norites. These represent a basic segregation in the cooling of the magma from which norite is derived. The presence of much hypersthene is undesirable, for the mineral, on account of its iron content, is easily decomposed on exposure to the corrosive agents of the atmosphere.

Augite is for the most part a normal metasilicate of calcium, magnesium and iron. Hardness 5.5. Specific gravity 3.4. Its color is usually green or greenish black and the crystals are short, thick and prismatic. Its cleavage angles of approximately 87 and 93 degrees, together with its grayish green color, readily distinguish it from hornblende. It occurs sparingly in some building stones like the nordmarkite of Mount Ascutney, Vermont. It is an essential constituent with the triclinic feldspars in diabase and basalt. By a conversion of the augite into hornblende the latter rocks pass into the diorites.

The Nephelite Group. The only member of the nepheline group of minerals occurring as an essential constituent in building stones is nephelite. It is an orthosilicate of aluminum, sodium and potassium. Its hardness is 5.8. Its specific gravity is 2.65. Its home is with the intermediate and basic rocks rather than with the acidic. The syenites bearing the variety of nephelite known as eleolite often present a greasy appearance suggestive of an oiled surface. Free quartz is absent, for if an excess of silica sufficient to form quartz had been present in the magma then the acid feldspars would have been formed instead of nephelite. Its presence in a building stone is easily established by pulverizing a few grams of the rock and digesting it with concentrated HCl or dilute HNO_3 when, in the presence of nephelite, the silica of this mineral will separate out as a gelatinous product of decomposition.

The Chrysolite Group. The one important member of this group is the orthosilicate of magnesium and iron, olivine, in which the ratio of the magnesium to the iron varies widely. Some analyzed samples have shown this ratio as 16:1, others as 2:1. Its hardness is 6.7. Its specific gravity is 3.3. The mineral is named from its olive green color. Its home is with the basic and ultrabasic rocks. In its metamorphism it passes into serpentine which sometimes becomes a highly decorative structural stone yet better suited for decorative interior work.

The Epidote Group. The one important member of this group of minerals is epidote itself. Its hardness is 6.8. Its specific gravity is 3.3. It is an orthosilicate of calcium, aluminum and iron with a little water of crystallization. It is of a peculiar pistachio green color seldom represented by other minerals. It is sometimes found sparingly in granites as at Enfield, N. H., and is a common constituent of many gneisses, schists and serpentines.

The Hydrous Silicates. The three hydrous silicates of considerable significance in structural and decorative stones are chlorite, serpentine and talc.

Chlorite. The term chlorite embraces a considerable number of minerals closely related to the micas, but differing from them in brittleness and in a larger percentage of water Chemically considered the chlorites are silicates of aluminum, iron and

magnesium, with chemically combined water. They are characterized by their green color, perfect cleavage and inelastic foliae. Their hardness varies but approximates to 2.5 and their specific gravity falls between 2.5 and 2.9. Chlorites are secondary minerals derived from the alteration of amphiboles, pyroxenes and micas.

The mineral imparts a green color to the chlorite schists which often consist of scales of chlorite and grains of sand. Chlorite is the ferromagnesian mineral in certain gneissoid granites like that of Lebanon, N. H., which was first classified as a protogene gneiss. The chlorite is here derived from the metamorphism of biotite.

Serpentine is a hydrous silicate of magnesium, $3MgO, 2SiO_2, 2H_2O$. Hardness varying from 2 to 4. Its specific gravity is 2.65. It occurs in varying shades of green, sometimes greenish black. It crystallizes in the monoclinic system, but it is the massive form that finds use as a decorative stone. When it occurs with calcite, magnesite and dolomite it constitutes the verd antique marbles. It sometimes occurs as minute green patches scattered through other marbles where its presence is objectionable. It occurs also as a metamorphic product resulting from the alteration of the magnesium silicates in diabase, basalt and peridotite. Massive serpentine is easily recognized by its inferior hardness to marble, its green color, its absence of cleavage planes and the large percentage of water derived upon ignition.

Talc is an acid metasilicate, $3MgO, 4SiO_2, H_2O$. Its hardness varies from 1 to 2.5. Its specific gravity is 2.75. Its color shades from white to green. When it occurs in the massive form it constitutes the useful stone known as steatite, which finds application in laboratory tables, sinks, stationary washtubs, stoves, etc. The mineral is easily recognized by its soapy feel and the ease with which it can be abraded with the thumb nail.

The Carbonates. Calcite, aragonite and dolomite are the three carbonates that occur as essential minerals in building stones. They are easily distinguished from the preceding minerals by their effervescence in HCl. They are secondary in origin resulting largely from the alteration of other minerals,

together with the solution and fine comminution of the testa of mollusks and crustaceans.

Calcite occurs filling the minute cavities in the rocks of all classes and of all ages. Formula, $CaCO_3$. Its specific gravity is 2.71. Pure statuary marble contains little else than calcium carbonate. It furnishes the essential constituent in most marbles, and is one of the two requisite constituents of dolomites. Calcite is easily recognized by its definite hardness of 3, by its facile cleavage and consequent brittleness and by its rapid effervescence with cold dilute HCl.

Aragonite has the same formula as calcite, but instead of crystallizing in rhombohedrons of varied habit like calcite it falls in the orthorhombic system in prismatic forms. Its hardness is 3.7, and its specific gravity 2.95. Some decorative marbles, like the onyx of San Luis Obispo, California, are nearly pure aragonite. The mineral is distinguished from all others save calcite by rapid effervescence in cold dilute HCl, and from calcite by falling to pieces before the blowpipe and by turning a beautiful pink when the fine powder is boiled with the nitrate of cobalt.

Dolomite is a double carbonate of calcium and magnesium, $CaCO_3$, $MgCO_3$. Its hardness is 3.7 and its specific gravity 2.85. It crystallizes in the hexagonal system in rhombohedrons with curved faces, often with a pearly luster. It effervesces slowly, if at all, in cold dilute HCl but rapidly in warm HCl. Many of the white marbles like that of Stockbridge, Mass., and the mottled marbles like those of Swanton, Vermont, are dolomites.

Gypsum, $CaSO_4$, $2H_2O$, is the only sulphate that occurs as an essential constituent of any building stone. Its hardness is 2 and its specific gravity 2.3. In color it is usually white, but sometimes grayish. It crystallizes in the monoclinic system with forms simple in habit. The mineral seldom occurs in the crystalline rocks, but it forms extensive beds among the stratified limestones and clays, where it becomes a rock mass of large commercial significance. Alabaster is a fine translucent variety that is used for ornamental purposes. In the absence of the water of crystallization the mineral passes into anhydrite, which has been substituted sometimes for white marble. This

use is objectionable, for anhydrite absorbs water upon exposure and expands thereby, throwing buildings out of plumb.

The Non-essential Minerals. The number of non-essential minerals sometimes occurring in building stones approximates forty. In many cases these are microscopic constituents. In others they are visible to the eye and easily recognized. The lack of space will permit an outline of only a few, and these will be the ones most objectionable when present in any building stone.

Pyrite, FeS_2, is a disulphide of iron. Its hardness is 6.3. Its specific gravity is 5. In color it is a pale brass yellow. It occurs in building stones in the form of cubes of the isometric system and in a microscopic granular and amorphous condition. In this latter form its oxidation is far more active than when in cubes. In its decomposition either soluble sulphates or free sulphuric acid is formed and the stone soon presents a dingy and unkempt appearance. In the calcareous rocks bearing magnesium the presence of pyrite becomes exceedingly objectionable. The free sulphuric acid formed in the decomposition of the pyrite unites with magnesium and forms a soluble efflorescent salt that creeps to the surface and is replaced from time to time by the less soluble, yet objectionable, calcium sulphate. According to James Hall efflorescence is frequently observed on buildings constructed of the bluestone of the Hudson River group. In case the mortar with which the structural blocks are laid contains magnesium efflorescent patches may be observed creeping mainly from the joint planes and bedding planes of the finished structure. Such an exhibition may be seen on St. Peter's Church, State Street, Albany, N. Y.

Marcasite has the same chemical formula as pyrite, FeS_2. Its hardness is 6.3 and its gravity is 4.9. It crystallizes in prismatic forms in the orthohombic system and is paler in color than pyrite. A. Julien has pointed out the greater tendency of marcasite to undergo atmospheric alterations and shown its profound influence upon the durability of building stones. Where the two forms of iron disulphide occur together, either through crystallization or alteration, as the proportion of marcasite increases the specific gravity of the rock mass decreases, the

color becomes paler, and the danger of objectionable weakening and discoloration is increased.

Owing to the tendency of all sulphides to decompose upon exposure to the atmosphere structural stones showing their presence should be rejected. Sulphur to the amount of .2 per cent may be readily detected by fusing the rock in powdered form with sodium carbonate on charcoal with the blowpipe, transferring the fused mass to a silver coin, moistening with water, when in the presence of sulphur, a dark stain due to the formation of silver sulphide will appear on the coin.

Siderite is a carbonate of iron, $FeCO_3$. Its hardness is 3.7 and its specific gravity 3.8. Its color is usually gray, but it turns brown upon exposure to the atmosphere. The mineral crystallizes in curved rhombohedrons of the hexagonal system and occurs as scattered crystals or in groups in many clays and limestones. Any limestone, dolomite or marble, bearing even microlites of siderite will soon present a dull or dead surface. 0.1 of 1 per cent of this mineral can be detected by the borax bead which in its presence becomes bottle green in the reducing flame.

Ankerite, $2CaCO_3$, $MgCO_3$, $FeCO_3$, is a triple carbonate. Its hardness is 3.7 and its specific gravity 3. It crystallizes in the same forms as siderite. Its occurrence in building stones is less frequent than that of siderite, but when present it is always objectionable.

Hematite, Fe_2O_3, is an oxide of iron. Its hardness is 6 and its gravity 5. Its color shades from red to black, but its streak is cherry red or blood red. It occurs in the rocks of all ages. The specular variety is mostly confined to the crystalline or metamorphic rocks. In granites it is usually confined to minute scales of bright red color. In an amorphous form it furnishes the cement in the red or brownish sandstones. Its occurrence as a cement is not as frequent as that of the hydrated oxides of iron, turgite and limonite. These are present in the Triassic sandstones of Longmeadow, Mass.

Magnetite, Fe_3O_4, is distinguished from the other oxides of iron by its black color and strong magnetism. Its hardness is 6 and its specific gravity is 5.1. It crystallizes in regular octa-

hedrons of the isometric system. Its home as an original constituent is in many granites and metamorphic sedimentaries. It is almost invariably present in the basic igneous rocks. Whenever magnetite is present in an appreciable quantity in any rock it ultimately becomes converted into the hydrated oxide of iron which stains the stone a rusty red color.

Limonite, $2Fe_2O_3$, $3H_2O$, usually occurs in stalactitic and botryoidal or mammillary forms, having a fibrous or subfibrous structure. It may also occur in concretionary, massive and earthy forms. Its hardness varies from 5 to 5.5 and its gravity from 3.6 to 4. In all cases it results from the alteration of other iron minerals, or iron-bearing minerals through exposure to moisture, atmosphere, carbonic, or organic acids. Pyrite, marcosite, pryrrhotite and siderite are particularly prone to yield limonite. The formation of limonite from some of the above mentioned sources is a common cause of discoloration in stone structures.

Garnet, $3RO$, R_2O_3, $3SiO_2$. R stands for the bivalent metals like calcium and magnesium, R_2 represents the trivalent metals like aluminum and ferric iron. The hardness of garnet is 7. Its specific gravity is 3.3. In color the mineral shades from white to red. It crystallizes in the isometric system in regular dodecahedrons and leucitohedrons. Its home is with the granites, gneisses, schists, limestones, and sometimes serpentines. Occasionally it appears in the basic irruptives. Its presence in any type of building stone is objectionable. On account of its brittleness it breaks away from its matrix in the dressing of a stone and renders a perfect polish far more difficult to obtain. Iron garnets break down due to the oxidation of the iron on long exposure to the atmosphere and the stone becomes stained with the characteristic iron rust.

CHAPTER III.

PHYSICAL PROPERTIES AND WEATHERING OF BUILDING STONES

Physical Properties. The physical properties that materially affect the value of building stones may be summed up as follows: Color, hardness, specific gravity, density, texture and state of aggregation.

Color. The color of a building stone is the quality of light reflected by its constituents. It may be due to the kind of light reflected by a single mineral as in statuary marble, where the only mineral necessarily present is white calcite. The color may be due to one or more of several causes. Red feldspars render prevailing color of the granite containing them red. A gray color may result in a granite from a commingling of the small feldspar crystals with scales of mica, muscovite or biotite, or both. Microlites of ferrous compounds in the cleavage planes of the feldspars produce a green coloration as in the granites of Nordmark, Norway; Mt. Ascutney, Vermont; AuSable Forks, New York.

The red color in sandstones may result from the presence of ferric oxide as a pigment in the sand grains themselves or as a cement binding the sand grains together. Hematite and turgite together produce a reddish brown color as in the sandstone of East Longmeadow, Massachusetts; clay as a cement produces a drab or neutral gray color as in the sandstones of Rockcastle County, Kentucky. A gray color may also be produced by the carbonates and the sulphides of iron. The pigment in the black marbles is largely uncombined carbon. Small quantities of carbonaceous matter in many limestones in Kentucky produce a gray coloration.

The color of building stones is not always permanent. Some granites when freshly quarried are gray, but turn green upon exposure to the atmosphere. Limestones containing carbonaceous matter often bleach. The red and green slates often fade.

Hardness. The hardness of a mineral is its resistance to abrasion. The resistance to abrasion in a building stone depends

upon two factors. (1) The hardness of the individual grains that compose the stone. (2) Their state of aggregation.

A sandstone with each individual sand grain No. 7 in hardness will wear away very rapidly when the cement that binds the sand grains together is weak. Clayey matter and calcium carbonate are often weak cements. Where presure alone causes the interlocking of the sand grains as in the itacolumyte of North Carolina the stone will wear away very rapidly.

Specific Gravity. The specific gravity of a building stone is its weight compared with an equal volume of water. The weight per cubic foot may be ascertained by multiplying the specific gravity of the stone by 62.5, the weight of a cubic foot of water. The weight per cubic foot of limestone ranges between 166 and 175 pounds. The more dense a stone is the heavier it will be.

Density. The density of a stone is its degree of compactness. The more dense a building stone is the less water it will absorb. The more quarry water there is in a building stone at the time it is quarried, the greater is the danger of injury to the stone from freezing. The more dense a building stone is the greater is its compressive strength and the higher its tensile strength.

Texture. The texture of building stones is widely varied. Pegmatites are often coarsely porphyritic. Some of the granites of England have large phenocrysts of orthoclase in a fine to medium grained ground mass. Breccias contains angular fragments, either smaller or larger, cemented together. Large rounded pebbles often appear in conglomerates. This characteristic obtains in the jasper conglomerate of Brazil. The texture ranges from medium to coarse in the marbles of Georgia. It is fine in the statuary marble of Carrara, Italy, and in the slates derived from the ashes of extinct volcanoes. The texture is fine in granites if the individual grains are less than 0.2 inches in diameter, and coarse grained if the individual crystals are grains exceeding 0.4 inches in diameter.

State of Aggregation. The state of aggregation of the individual constituents of a building stone influences both the hardness of the stone and its working qualities. If the grains

adhere loosely the stone is friable. Flinty building stones are exceedingly fine grained and compact.

Chemical Properties. The chemical composition of a stone is often a guide in its selection and value for building purposes. A chemical analysis will reveal the presence of microlites of injurious constituents. The carbonate and sulphides of iron are thus detected. Their presence in any building stone causes the stone to discolor and become unsightly upon exposure to the atmosphere. A complete chemical analysis of the Bowling Green oolitic limestone reveals the presence of bituminous matter. This bitumen renders the stone somewhat dingy when freshly quarried, but the oily substance soon evaporates and leaves the stone white and beautiful.

Structures That Aid in Quarrying. The structure in sedimentary rocks is anticlinal when an arch-like fold inclines in opposite directions from an axis. It is synclinal when they form a trough-like fold or bend in the same direction.

Joint planes are common features in the rocks of all ages. They may result from several different causes. (1) By the cooling of a molten mass. (2) By the lowering of the temperature produced in folding and uplift producing mountains. (3) By lowering the temperature produced in chemical change. (4) By compressive and tortional strains. (5) By vibratory strains.

Bedding planes correspond in the sedimentaries to the natural divisions that separate the successive layers into blocks of varying thickness. Blocks of unusual thickness may increase the cost of quarrying, but this is often compensated by a smaller amount of waste material. Where many of the beds are too thin to produce stone of specified requirements, there is much waste of rock unless the thinner beds are used for paving blocks.

Rift and Grain. Building stone must have three dimensions. There are three directions along which building stones split with more or less ease. The skilled quarryman takes advantage of these directions in both quarrying the stone and in manufacturing dimension blocks.

The rift is usually parallel with the major joints. The grain is at right angles to the rift. The third direction, which

is at right angles to the other two, is called the end grain or the head grain. The head grain may be poor even though the stone may work easily in the other two directions. The rift may be due to (1) An obscure microscopic foliation which may be either vertical, or nearly so, or horizontal, along which the stone splits more easily than in any other direction. (2) A parallel arrangement of the various mineral particles. (3) Microscopic faults. These in the igneous rocks may meander across the feldspar and quartz alike, or it may go around some of the quartz grains rather than across them. (4) Pressure phenomena in a magma after its consolidation.

Compression. The compressive strength is the weight a building stone will stand without fracture. It is expressed in terms of pounds per cubic inch. In good granites the range varies from 15,000 to 33,000 pounds to the cubic inch. In constructional limestones and marbles it ranges from 13,000 to 17,000 pounds per cubic inch.

Compressive strength depends upon three different factors. (1) The mineral composition. (2) The size of the individual constituents. (3) Their state of aggregation.

Transverse Strength. This is a load which a bar of stone with one inch cross section, resting on supports one inch apart, and with weight applied in the middle, is able to withstand without breaking. It is measured in terms of the modulus of rupture. Building stones are more apt to be broken transversely than crushed.

The Weathering of Building Stones

The changes that a stone undergoes upon exposure to the corrosive agents of the atmosphere are (1) Chemical; (2) Mineralogical: (2) Structural.

Chemical. Water usually carries dissolved oxygen and carbon dioxide. These agents partially dissolve the more soluble materials with the liberation of colloidal silica and the formation of the carbonates of calcium, magnesium, sodium, potassium and iron. The alkaline earth carbonates, the carbonates of the alkalies and much of the dissolved silica are carried away in solution, the unstable iron carbonate is broken up with the liberation of carbon dioxide and the formation of the hydrated

oxides of iron which produce the unsightly appearance so often presented by building stone. The undissolved residues often hydrate. The feldspars are transformed into kaolinite. The magnesium compounds pass into talc or serpentine. This process of solution and hydration is accompanied with an increase in volume which may assist in effecting disintegration.

Coal often carries sulphur in combination with iron as the mineral pyrite, FeS_2. In the burning of the coal the sulphur unites with oxygen and moisture to form sulphurous acid, which ultimately becomes sulphuric acid. This corrosive agent dissolves the lime as calcium sulphate which may crystallize as gypsum. It attacks the mortar and cement with which blocks of stone, terra cotta and brick are bound together, and brings into solution the soluble constituents. Nitric acid, hydrocloric acid and ammonia also accelerate the decomposition of building stone. Salt laden sea breezes along coast lines favor the solution of carbonates, sulphates and the lime silicates.

Vegetation. Microscopic algae, mosses and lichens find lodgment on buildings and aid in rock decay. Their destructive effect is due to three causes. (1) They retain moisture and make the surface beneath them damp. (2) Their rootlets and roots penetrate into the surface of the rocks. (3) Their roots contain organic acids which serve as solvents for minerals.

Bacteria. Bacteria draw their nourishment from the nitrogen compounds formed during storms and convert the ammonia into nitric acid. This acid is a strong corrosive agent.

Physical Agencies. The expansive effect of heat upon building stones has often been observed. The contraction as the temperature lowers may not be to normal. Sidewalks are known to buckle from three to six inches in height and to be subsequently broken. A pendulum suspended from the top of Bunker Hill Monument on a clear day will describe an irregular ellipse nearly half an inch in its greatest diameter. The change may seem to be small, yet the entire shaft has been set in motion. The monument is 30 feet square at the base, 221 feet in height, and was erected of Quincy granite in 1825.

Frost. The greater the porosity of a building stone the more water it will absorb. When the temperature falls below the freezing point and the water in the stone solidifies, small scales

are thrown from the surface and even large blocks may be fractured. Porous sandstones are particularly prone to disintegration under such conditions.

Friction. The effect of friction in the constant abrasion of building stones is often observed on sidewalks, on the treads of stairways in many buildings, on the threshold at the main entrance to libraries, and on the inlaid floor in the rotunda of hotels. In the selection of stones for such uses, resistance to abrasion becomes an important factor.

Wind-blown sand slowly wears away the less resistant materials in many stone buildings, and decorative fences. It effaces the inscriptions on monuments and markers, and renders windows non-transparent. This feature is especially noticeable in some of the Western States.

Induration. When a building stone is first quarried it is saturated with water. This water holds in solution, or suspension, an appreciable amount of the cements that bind the mineral grains together. Upon exposure to the atmsophere this quarry water is drawn to the surface by capillary attraction and evaporated. The dissolved constituents are thrown out of solution by the evaporation of the solvent and function again as cements. Honing, rescouring and redressing of stone after the quarry water has evaporated should be avoided, because each process renders the destruction of the stone more rapid.

Life. The life of a building stone is the length of time that may elapse before the resulting stone structure will so discolor or disintegrate as to necessitate repairs. The life varies widely with the different types of stone used and the severity of the climate where the structure stands. A. Julien has carefully studied these factors in many stone structures in New York City with the following results:

Coarse brownstone	5 to 15 years
Fine laminated brownstone	20 to 50 years
Compact brownstone	100 to 200 years
Coarse fossiliferous limestone	20 to 40 years
Coarse dolomitic marble	30 to 50 years
Fine dolomitic marble	60 to 80 years
Fine grained marble	50 to 100 years
Granite	75 to 200 years
Quartzite	75 to 200 years

Selection of Building Stone. The following rules are here given that the architect, engineer, contractor, builder, may select the better and more permanent types of structural stone:

(1) Select a stone that will resist wide ranges of temperature. The coquina of Florida would rapidly disintegrate in New England.

(2) Select a stone that will stoutly resist the corrosive effects of the acids and gases of the atmosphere. A calcareous cement is more rapidly attacked than silica.

(3) Select a stone with high compressive strength and elasticity. The Caen, France, limestone has given a compression test of 3,350 pounds per square inch, while the Bethel, Vermont, granite resists 33,153 pounds per square inch.

(4) Select a stone with large resistance to abrasion.

(5) Select a stone that always shows a clean fresh fracture.

(6) Select a stone that gives a clear sharp ring when struck with the hammer.

(7) Select a stone that is free from the sulphides and the carbonate of iron.

(8) Select a stone that is fine grained and even textured.

(9) Select a stone with low porosity.

(10) Select a stone, if possible, with a siliceous cement.

(11) Select a stone that is dressed while the quarry water is present in the stone.

(12) Season a stone for a year before setting it in its permanent position. Some quarrymen will object to this method of procedure. It is just as essential to season stone as lumber.

Methods of Testing Building Stone

There are several well known and standard tests that are often used to determine the value of a given building stone.

Color Test. This test is applied to determine the permanency of color. This may be effected (1) By seasoning the stone for a year. (2) By laboratory tests for the detection of sulphides. (3) By laboratory tests for the detection of the carbonate of iron. (4) By subjecting the stone to an artificial atmosphere containing corrosive reagents.

Corrosion Test. The resistance to abrasion can be roughly estimated by grinding a small sample on a common grinding bed. Soft rocks like the uncrystallized limestone wear away rapidly, while the quartzites and granites are resistant.

Absorption Test. This test is very important and conclusive, but not always absolutely reliable. The percentage of absorption in building stone varies from 0.83 to 10.06.

Freezing Test. The best method to pursue when possible is to subject the samples to repeated freezings and thawings, and thereby determine the loss in weight.

Expansion and Contraction Tests. These tests are necessary in order that the builders may make proper allowance for expansion in parapet walls and similar positions, and because the tenacity of a stone is weakened by expansion and contraction. Bars of stone may be placed in water at 32°F, then in water at 212°F, and then cooled quickly in water at 32°F. The permanent swelling proves that bars thus treated do not return to normal dimensions.

Fire Resisting Test. Building stones are sometimes heated to a red heat and cooled. The process may be repeated several times. They may then be heated to a dull redness and immersed in cold water. Most building stones will crack and crumble under such treatment, and the test seems too severe.

Compression Test. The sample to be tested may be a 1, 2, 3, 4, or 5 inch cube. The smooth faces are placed between steel plates and the pressure applied. The pressure is relieved at the first sign of breaking in the sample and the weight of pressure recorded.

Elasticity Test. To determine the elasticity of a stone, a sample 24 inches by 6 inches by 4 inches is selected. The power is applied from the ends. The compressibility is measured with a micrometer. The stone shows a permanent set from which it never recovers.

Shearing Test. In this test prisms of stone are supported at each end and subjected to pressure by means of a plunger which exerts a force in all directions. The strain is like that exerted in many parts of a building.

Transverse Strength Test. In this test a bar of stone with one inch cross section rests upon supports one inch apart, and the pressure is applied midway between the two supports. The result is stated in terms of the molulus of rupture.

Specific Gravity Test. A fragment about the size of a pea of the stone to be tested is first weighed in air and then in water, and the weights recorded. Let W equal the weight in air and W^1 the weight in water. Then W divided by W minus W^1, $\frac{W}{W-W^1}$, equals the specific gravity of the sample tested. This result multiplied by the weight of a cubic foot of water 62.5, gives the weight of a cubic foot of the building stone.

For a fuller description of the methods of testing building stone, architects, contractors, engineers, and builders are referred to pp. 457-483 inclusive in "Stones for Building and Decoration," by Dr. George P. Merrill. A detailed presentation of the physical properties and weathering of building stones is given in the author's text, "Building Stones and Clays."

CHAPTER IV.

SEDIMENTATION

Sedimentary rocks may consist of materials derived through the disintegration and decay of earlier land masses. The parent rock may have been of igneous, sedimentary, or metamorphic origin. They may also consist of matter produced by life in the sea. The former type of material is of continental origin and the latter is of marine origin.

Residual sands remaining at or near their point of derivation become a residual sandstone. Such sandstones are often arkosic and of somewhat limited extent. Broken fragments of shells may be cemented together by the carbonate of lime without transportation to any considerable distance.

It is evident that most of the sedimentary deposits have been shifted from their point of derivation and deposited by the action of water. Sedimentary rocks are always understood to have been formed by the agency of water unless otherwise stated. Water formed rocks are by far the more widely distributed and the greatest in volume.

Stratified rocks formed by the action of the atmosphere are known as aeolian rocks. They are of limited distribution and of minor importance. Sands to be transported by the wind must be fine and dry. For the formation of a sand dune there must be some obstacle to check the velocity of the wind that it may deposit a part at least of its burden of sand.

Materials. The minerals that make up the stratified rocks are those that most strongly resist decomposition, oxidation and abrasion. Quartz, with a hardness of 7 and without true cleavage, is the most common constituent. It is the basis of most sands, but not of all. The black sand of the Adirondacks is magnetite. Kaolinite is the most common constituent of muds and clays. It results largely from the decomposition of the various feldspars in rocks.

The carbonate of lime in many muds may have been derived from limestones or from comminution of shells, etc., in the sea.

Classification as to Size. Transported rock waste may be divided into gravel, sand, silt, mud or clay. Gravel may be

subdivided into fine gravel with sizes a little larger than a pea, medium gravel and coarse. The large rock fragments that may be transported are also called boulders. These may be either glacial or torrential.

The sands may be subdivided into fine, medium and coarse. The coarse sand must not exceed the size of a pea. The fine sand must not cohere, when wet. The muds or clays are usually plastic when wet, but pure kaolinite is non-plastic.

Sandstones

Sandstones belong to the sedimentary and detrital rocks. They represent the reconsolidated products of rock decomposition. They consist, therefore, of grains of sand held together by some cementing material. In composition they vary as widely as the sands of the seashore or the river banks. In one respect there is a wide difference and that is the presence of cementing materials. Essentially they represent grains of quartz, SiO_2, and some cement. Other minerals like the amphiboles, pyroxenes, magnetite, chromite, cassiterite and monazite, may resist decomposition and remain near the place where they were derived, as sand. Each of these groups may be bound together by some cementing material and produce a sandstone of unusual type.

The impurities in the sandstones are the minerals normal to the sand beds that suffered cementation, and their metamorphic derivatives. Siderite, pyrite, garnet, zircon, apatite, rutile, ilmenite, titanite, muscovite, biotite, and chlorite may appear.

The texture of sandstones varies from the fineness of dust particles, sandy material that may be held in suspension for a considerable period of time and deposited, to individual pebbles several inches in diameter. When these larger rock fragments are water worn and well rounded the stone passes over into a conglomerate like the widely distributed and well-known Pottsville conglomerate at the base of the Pennsylvanian series. When the fragments are distinctly angular the rock becomes a breccia. The term conglomerate is sometimes used to cover the breccias. Both angular and well-rounded pebbles may occur in the same formation. If the fracture goes around the coarser fragments

the rock is a conglomerate, but if the fractures cross the larger fragments the rock has been metamorphosed into a quartzite.

The color in sandstones may arise from the color of the individual sand grains themselves or from the character of the cements introduced. Usually the color is more dependent upon the nature or composition of the cementing material than it is upon the color of the sand grains themselves. If the cement is the anhydrous oxide of iron, hematite, Fe_2O_3, the stone will be red. If hematite, Fe_2O_3, and turgite, Fe_2O_3, H_2O, the stone will be reddish brown. If it is the hydrated oxide of iron, limonite, $2Fe_2O_3$, $3H_2O$, the stone will be yellow or yellowish brown. If it is clayey matter the stone will be gray or blue. Blue coloration may also be caused by microlites of pyrite, and the gray by microlites of siderite. If the cement is chlorite the stone will have a greenish tint. If the cement is pure silica, SiO_2, and the original sand grains were pure quartz the sandstones will be white or creamy white in color and its metamorphic derivative, quartzite, will also be white.

The different varieties of sandstone are based upon several factors as mineral composition, structure, and the character of the cementing material. The cementing material may be calcium carbonate. The product is then called a calcareous sandstone. It passes by insensible gradations into a siliceous limestone. A kaolinitic sandstone is one whose cement is kaolinite. A glauconitic sandstone is one containing green-sand marl. An argillaceous sandstone is one containing clayey matter. This is one of the commonest cements. The resulting sandstone passes by insensible gradations into a shale. A ferruginous sandstone is one bearing some compound of iron. Such sandstones may reveal the presence of iron by their color. If the iron is present as a pigment in a stable cement the sandstone is very durable.

A feldspathic sandstone, as the name implies, contains fragments of feldspars in addition to the grains of silica as quartz. Its parent source was the decomposition of some granite or gneiss. In its metamorphism it passes into a paragneiss. A barytic sandstone is one whose cement is barite, $BaSO_4$. A phosphatic sandstone is one containing calcium phosphate and a bituminous sandstone is one bearing bitumen.

A quartzite is a metamorphic sandstone whose cement is silica. Often the new silica has a like optical orientation with the original quartz grains. Such sandstones are the most durable of all rocks. A greywacke is a sandstone consisting essentially of quartz, feldspar and fragments of slate bound together by argillaceous, calcareous, or even feldspathic material. Flagstone is a name derived from the ease with which a sandstone splits into slabs suitable for flagging on sidewalks. Freestone is the name applied to the varieties that split freely in all directions. Itacolumyte is the name given to the flexible sandstone of North Carolina in which the sand grains are interlocked by pressure.

The cements in sandstones are as varied as the sand grains themselves. Pressure alone may cause the sand grains to interlock and produce a friable and flexible variety known as itacolumyte. Percolating waters charged with calcium carbonate provide the carbonate for binding the sand grains together. The amount of this cementing material may be quite subordinate, or the percentage may equal or even exceed that of the sand grains. In the latter case, the rock is best classified as a siliceous limestone. The gaize of the French geologists is a siliceous sandstone containing grains of quartz and glauconite which are cemented together by opaline silica, chalcedony, clayey matter and the carbonate of lime. Opaline silica may be easily detected as a cement for it passes readily into solution in a weak caustic alkali, while ordinary quartz is only sparingly soluble in a weak alkali.

Silica itself may serve as the cementing substance. It may appear either as the amorphous silica or in crystalline form. In the former case the silica fills the interstices between the sand grains, while in the latter case the sand grains themselves become the nuclei for distinct quartz crystals. When the sand grains are well rounded and of equal dimensions the actual pore space reaches 24 per cent, but the actual space on account of the irregularity or the inequality of the grains is usually much greater. With silica for a cement, there is every gradation possible between a friable rock and a compact solid rock which in its metamorphism passes into a hard, vitreous quartzite with the longest life of any known building stone.

The anhydrous and hydrous oxides of iron serve often as the cementing material. These cements impart their characteristic colors to the sandstones in which they appear. Hematite tends to impart a red color. The sandstones of the southern shore of Lake Superior bear this cement. The Triassic Sandstones of New England bear hematite and turgite. The Tertiary sandstones of the Appalachians carry turgite. The durability of the Triassic sandstones can be seen by any visitor in Washington, for the Smithsonian Institution was constructed from this stone in 1848-1854.

The hydroxide of aluminum as well as clayey matter may fill the interstitial spaces between the sand grains and form a fairly satisfactory stone for constructional work. Clayey matter is largely the cementing material in the sandstones of Rowan and Rockcastle Counties in Kentucky.

Barytic sandstones occur in which the cementing material is barium sulphate. The waters in this case percolating through the sand beds bore barium carbonate and soluble sulphates which would react upon each other, forming barium sulphate, $BaSO_4$, and soluble carbonate. The carbonate would be carried away in solution while the insoluble sulphate would render a barytic sandstone most durable.

Gypsiferous sandstones in which gypsum functions as the cementing material are known in the Astrakan steppe. Calcium phosphate serves as the cement in some of the sandstones of Tennessee, and Kursk, Russia. Fluorite is the cementing material in the sandstones of Elginshire, Scotland. G. P. Merrill cites the phosphates of iron as rare cementing materal in sandstones. F. W. Clarke cites bituminous substances serving as cement and further states that any substance which waters can deposit in a relatively insoluble condition may serve as a cement to bind sand grains together.

The sandstones of the world are not confined to the rocks of any particular geologic age. They appear in the rocks of all ages from the Archaean to the present time. The commercial sandstones, however, are not younger than the Cretaceous. The commercial sandstones of Kentucky belong to the Mississippian formations.

Quarrying Sandstones. The method used in quarrying sandstones depends somewhat upon the character of the joint planes and the thickness of the beds. In thin bedded sandstones that adhere feebly to the underlying sheets blocks of the desired size may be obtained with drills and wedges. In some instances the channelling machine is used to cut vertical channels in the various beds. Where the blocks are thick bedded holes are sometimes drilled 10 inches in diameter and 20 feet deep. About 50 pounds of powder in an oval tin canister with unsoldered edges and ends covered with paper or cloth is lowered into the hole and placed so that a plane passing through its edges is in the direction of the desired break and then fired. The loosened blocks are then split into smaller dimensions by wedges.

The Knox system consists essentially of making a series of elongated holes along the line of the desired break, putting in a light charge of powder, leaving an air chamber between the powder and the confining plug and firing all simultaneously with an electric battery. It requires a special reamer for the elongation of the drill hole.

The Lewis system consists of drilling two holes about half an inch apart, cutting out the rock between the two holes, filling with powder and blasting in the same manner as in the Knox system.

The Githens system drills the hole with a single drill in the oval shape desired. The stone is then blasted as in the preceding systems.

Whatever the system of blasting may be there is always some danger of loss of material through fractures induced by blasting. The heavier the charges of powder used the greater this danger becomes. Sometimes these planes are not noticed until the stone is dressed, or even set in its bed in structural work, yet in all cases such fractures are lines for the invasion of moisture and the stone disintegrates or crumbles. The less jar a sandstone receives from heavy hammers the greater will be its durability.

Uses. W. C. Day in the Stone Industry of 1894 gives the following summary of the uses of sandstones:

Foundations, Superstructures and Trimmings.

Solid fronts, foundations, cellar walls, underpinning, steps, buttresses, window sills, lintels, kiln stone, capping, belting or belt courses, rubble, ashlar, forts, dimensions, sills.

Street Work.

Paving blocks, curbing, flagging, basin heads or catchbasin covers, stepping stones, road-making, macadam, telford, concrete, sledged stone, crushed stone.

Abrasive Purposes.

Grindstones, whetstones, oilstones, shoe rubbers.

Bridge, Dam and Railroad Work.

Bridges, culverts, aqueducts, dams, wharf stone, breakwaters, jetties, piers, buttresses, capstone, rails, ballast, approaches, towers, bankstone, parapets, docks, bridge covering, bridge guards.

Miscellaneous.

Grout, hitching posts, fence wall, sand for glass, sand for cement, sand for plaster, furnace hearths, lining for blast furnaces, rolling-mill furnaces, lining for steel converters, fire brick, silica brick, core sand for foundries, adamantine plaster, cemetery work, millstones, fluxing, ganister, glass furnace, random stock.

Compression Tests. The compressive strength of sandstones varies widely. Some sandstones are extremely friable and with insufficient resistance to be used for structural purposes, while others like the metamorphic member quartzite are superior in strength to most of the granites.

Sandstones range in compressive strength from 2,400 pounds per square inch for the sandstone of San Jose, California, to 27,750 for the quartzite of Pipestone, Minnesota.

Limestones, Dolomites and Marbles

Definition. A limestone is any rock moss consisting essentially of calcium carbonate, $CaCO_3$, or of calcium carbonate intermingled with more or less magnesium carbonate. The calcium carbonate has been separated from water, rendered insolu-

ble and accumulated by the action of living organism, of various kinds. Such deposits may be mechanically broken up and redeposited, or they may be taken into solution, carried away and precipitated elsewhere. There are some possible exceptions to this rule and these will be cited later.

A dolomite is any rock consisting essentially of calcium carbonate and magnesium carbonate, $CaCO_3$, $MgCO_3$. Geologically speaking, a dolomite may contain a large amount of admixed calcite. Mineralogically, dolomite means a definite chemical compound of formula $CaCO_3$, $MgCO_3$. Limestones containing more than 5 per cent of magnesium carbonate are dolomitic. The magnesium carbonate of the dolomites has been added to organic limestones which were originally free from, or poor in, magnesia. The unstable forms of calcium carbonate, aragonite and conchite take up magnesia quite readily. Dolomites are distinctly crystalline, often porous and filled with drusy cavities.

From a mineralogical standpoint a marble is a metamorphosed limestone. It is distinguished from a limestone by its crystallization, coarser grain, greater compactness and purer colors. If fine, it is often very massive and shows no signs of schistose cleavage, even where its association with schists is such as to indicate that it must have been subjected to enormous pressure and shearing stresses.

Dolomitic limestones pass by insensible gradations into dolomitic marbles. We therefore have both calcite marbles and dolomite marbles. A metamorphosed calcareous rock is often called a marble whether it contains magnesia or not. From a petrographical and chemical standpoint there is an important difference between a calcite marble and a dolomite marble. This holds especially true in respect to the associated minerals they are apt to contain when impurities were originally present in them. The pure statuary marbles like those of Marble, Colorado, Western Vermont and Carrara, Italy, contain little else than the mineral calcite. Dolomite marbles usually contain some calcite in addition to the dolomite crystals. The white oolitic limestones of Barren and Caldwell Counties, Kentucky, carry little else than calcium carbonate. From a purely commercial stand-

point a marble is any limestone or dolomite, whether metamorphosed or not, susceptible of a polish and suited for decorative interior work or the purposes of massive construction.

Impurities. Limestones vary widely in their composition. They range from 25 per cent $CaCO_3$ to theoretically 100 per cent $CaCO_3$. The impurities are uncombined carbon which imparts a dark gray or black color to the rock, clayey matter which gives limestone a drab or gray color, pyrite, siderite, talc, serpentine, micas, amphiboles, pyroxenes and sand. Green-sand marl and phosphatic particles are sometimes present. Bituminous matter and even hydrogen sulphide may be encased in limestones. The former shows the presence of bitumen when heated, and the latter variety emits an offensive odor when struck with a hammer. Such a limestone is represented at Chatham, Canada, and in western Vermont.

Texture. The texture of the calcareous rocks is as varied as their composition. They range from the soft friable fine grained chalk to the compact and crystalline types. As a rule the older formations are the more compact and crystalline, while the younger formations are more apt to be friable.

Varieties. The numerous varieties are based upon several different factors as structure, chemical composition, mode of origin, uses, etc.

A pure marble consists of calcite crystals in a crystalline, granular aggregation. Saccharoidal marble is a variety that closely resembles loaf sugar in texture. Common compact limestone is often amorphous and homogeneous. A microscopic investigation reveals it to be an aggregation of crystalline calcium carbonate. Hydraulic limestone, which has so large a significance from an engineering standpoint, is a variety that contains 10 per cent or more of silica and the proper amount of clayey matter to make a cement that when the stone is burned will set under water. Lithographic limestone that has been used extensively in the preservation of stock patterns is a fine grained magnesian variety with its best representative found at Solenhofen, Bavaria. It also occurs in Estill and Meade Counties, Kentucky. Oolitic limestone consists of small, rounded, concretionary grains about the size of the egg of a brook trout.

A dolomite limestone is one containing 5 per cent or more of magnesium carbonate. In its metamorphism it passes into a dolomite marble. A true dolomite, however, would be represented by the double molecule, $CaCO_3$, $MgCO_3$, which characterizes some of our most handsome decorative marbles. There is every stage and gradation between calcite on the one hand and magnesite on the other. Travertine, known also as calcareous tufa, represents a chemical precipitate. Mexican onyx is a massive variety of travertine that is highly prized for its translucency and variety of colors. Stalactite is the variety that forms on the roofs of caves and stalagmite the one that forms in a similar manner upon the floors of caves. When the two varieties meet they form a pillar. The last three forms are well represented in Mammoth Cave and Great Onyx Cave, Edmonson County, Kentucky, and in Mammoth Onyx Cave, Hart County, Kentucky. Coquina is a variety that consists of broken shells held together by a cement of lime. The more compact massive forms are used for building purposes. A coralline limestone is one consisting essentially of fragments of coral. A fossiliferous limestone is one containing any identifiable fragment of the testa of some former animal. Such limestones are named from the prevailing species present, as crinoidal limestone when the fossils are the fragments of crinoidal stems.

Origin. The origin of limestones, dolomites and marbles is very diverse. The primary source is to be found in the decomposition of igneous rocks by carbonated waters. Calcium carbonate is taken into solution in ground water, springs and rivers, and subsequently withdrawn from solution by a variety of processes. It is deposited as a chemical sediment from hot springs and sea water and often precipitated as a cement in other rocks.

The different kinds of limestones consisting essentially of calcium carbonate, together with impurities of foreign material, are mostly of organic origin. The hard parts of calcareous organisms are composed of calcite or aragonite, or both, with a small amount of calcium phosphate.

Many limestones now consisting of calcium carbonate, calcite, may have been originally aragonite, the orthorhombic form,

for aragonite is unstable and tends to be converted into calcite. Aragonite falls to pieces before the blowpipe, while calcite is infusible.

Aragonite when pulverized and boiled with a dilute solution of the nitrate of cobalt is stained a lilac-red color, while calcite remains unchanged.

Among the organic fragments that yield calcite may be mentioned calcareous algae (Lithohamnion), foraminifera, some forms of corals, echinoderns, crustacea, polyzoa, brachiopods, a few of the molusca, and some of the gasteropods.

Those producing aragonite are the calcareous algae (Helimeda), most of the corals, some of the polyzoa, most of the molusca, gasteropods, cephalopods and petropods.

Waters charged with carbon dioxide become a potent solvent for rock constituents. This effect is illustrated by the numerous limestone caves in Kentucky and the Luray Caverns in Virginia. The surcharged waters when relieved of pressure deposit their load in some of the various forms of travertine. The stalactitic and stalagmitic marbles fall into this class. By this process also large masses of the compact variety known as onyx are produced. This type of decoratve interior marble is best represented in California and Mexico, but it is also well represented in Edmonson, Barren and Hart Counties, Kentucky.

Rivers flowing over limestone areas carry a certain amount of calcium carbonate in solution into the sea. A direct precipitation of this calcium carbonate can occur only when the supply of carbonate is in excess of that which can be consumed by living organisms and when the conditions of temperature and pressure are such as to expel the solvent, CO_2. Such deposits are exceptional rather than common. They are known to occur in the delta of the Rhone and in the everglades of Florida, where the inflowing waters are exposed in broad, shallow sheets to evaporation, agitation and variations of temperature and pressure. The calcium carbonate is partly thrown down as mud and partly deposited on the underlying limestones as a layer of rock. The alternation of beds of snow-white, bluish-gray, greenish and almost black layers in many marbles may perhaps be best explained on the assumption that the white layers were

deposited from solution and the darker layers were beds of indurated shell mud and sand colored by the organic impurities they contained at the time they were first laid down.

Great masses of calcareous tufa have been deposited around Pryamid and Winnemucca Lakes in Nevada. When the deposits assume the form of oolitic sand the carbonate is deposited around sand grains or other foreign bodies as nuclei. Similar formations around Great Salt Lake are formed only where there is much agitation of the waves.

The tufa requires surf to discharge the excess of carbon dioxide and deposit calcium carbonate. This formation of oolitic sand may be attributed to minute algae. Thallophytes, as Chara, and bryophytes, as mosses, are capable of extracting carbon dioxide and setting free calcium carbonate. When they do this in the presence of the bicarbonate they deprive that salt of the second molecule of carbonic acid and the neutral carbonate is thrown down. The material, at first porous, is afterwards transformed into a compact rock by the deposition of calcite in its interstices.

The shallow water limestones that show oolitic structure like many Kentucky oolites contain little spheroidal grains built up of successive coats of calcium carbonate. These are often sufficiently numerous to make up the chief bulk of the rock.

The concentric layers may have been formed upon a nucleus which may be a tiny fragment of a shell, some organic body, a pellet of fine mud, or a grain of quartz sand. Sometimes the original nucleus appears broken. Sometimes it is compound. The concentric shells may or may not show a radial structure.

The matrix surrounding the oolites consists of calcareous muds, mostly carbonate of calcium which has largely been derived from the attrition and disintegration of calcareous organisms although chemical deposition may play some part in furnishing the matrix.

In many limestones the original finely divded calcareous matter has been partially or wholly recrystallized into a granular mosaic of calcite. Sometimes this texture is fine. Sometimes it is very coarse. Again it may completely surround the remaining oolites, shell fragments, or detrital quartz grains. The

recrystallized carbonate of lime is always calcite for aragonite is converted by recrystallization into calcite, which is the stabler form of calcium carbonate.

The formation of the fresh water marls of New Jersey is due to the presence of algae. Chara is responsible for certain marl deposits in the Lakes of Michigan. Aquatic plants have been active in the formation of the marl deposits of Indiana. The smaller morainal lakes of Central New York are rapidly filling up with marl deposits. These lakes are comparatively shallow and many of them have their waters constantly aerated by strong wave-producing winds. The waters that serve as feeders for the lakes flow over limestone areas and carry much calcium carbonate in solution into them. The lakes are rich in their aquatic plants which consume carbon dioxide and exhale oxygen. The activity then of algae may be a potent influence in the formation of the marl deposits.

Albumen, which is present in the organic parts of all aquatic plants, may serve as a precipitating agent for calcium carbonate. Albuminoids generate ammonium carbonate by fermentation and by that compound the precipitation of calcium carbonate is due.

Waters charged with carbon dioxide dissolve aragonite far more rapidly than calcite, and aragonite shells largely disappear in limestone while calcite organisms remain permanently in fossil forms. At temperatures exceeding 60 degrees aragonite is more apt to be formed and below that temperature calcite. As coral life demands temperatures exceeding 68 degrees, aragonite may form and later become calcitized.

The formation of a coralline limestone may be followed easily in the fringing reefs, barrier reefs and atolls. The order is as follows: (1) The living animal, the coral polyp. (2) The dead animal with its home broken into fragments by the waves. (3) Cementation of these broken fragments by the solution and redeposition of a part of the calcium carbonate. (4) The solid rock composed of these organic remains. Such may bear both calcite and aragonite, deposited directly by the sea water. They may also carry both organic material and earthy matter.

They may also become dolomitized through the action of magnesium bearing waters.

The coquina of Florida and many other sea beaches affords illustrations of limestone building from shells. These broken fragments are cemented together by calcium carbonate which has been deposited from solution in the interstices between the shells. Limonite may also function as a cement and quartz sand may be commingled with the shell material.

Crinoidal limestones are formed from the disjointed fragments of the stems and arms of crinoids or sea lilies. The cross sections of such fragments vary from a small fraction of an inch to an inch or more in diameter. The smaller fragments have given rise to the decorative stone known as birdseye marble, but this name has also been applied to some of the coralline limestones of Iowa.

Oceanic ooze may be laid down on the floor of the sea and compressed into a soft rock like the chalk cliffs of England. Globigerina ooze appears in waters at a depth of 2,925 fathoms. Aragonite pteropod shells practically disappear at depths exceeding 1,500 fathoms. As the upper chalk beds of England carry only calcitic organisms, Kendall concludes that they must have been deposited in waters exceeding 1,500 fathoms in depth. These oozes were practically free from impurities, save chert nodules.

Calcareous sediments may be rich in clay or mud and produce a fine grained argillaceous limestone with every shade and gradation between a calcareous shale and a pure limestone. The sediments may also contain quartz grains, largely calcareous, and produce a limestone that is fine grained and hard. These rocks shade imperceptibly from siliceous limestones into calcareous sandstones. In the metamorphism of the latter the rocks pass into a quartzose marble.

Marbleization. The marbleization of calcium carbonate, or the conversion of amorphous carbonate into a crystalline limestone or marble, may be effected in a number of ways. Pressure alone, either long continued and gentle, or heavy and of short duration, may produce this change. It may be brought about by the influence of heat. Both heat and pressure may

work conjointly in effecting the marbleization of amorphous calcium carbonate. Water plays an important part for in geological phenomena its influence is rarely excluded. The solution and redeposition of calcium carbonate explains many changes in the structure of calcareous rocks.

Alteration. Changes in limestones may be effected by an infiltration of waters bearing silica in soluton. By the deposition of the silica the stone becomes silicified. A limestone may become phosphatized by the action of meteoric waters flowing over beds of guano. It may become gypsumized through the decomposition of inclosed pyrite and the acid sulphates formed through such decomposition. The most potent change is effected by waters charged with carbon dioxide. Impure limestones yield a large number of objectionable minerals through thermal metamorphism. Organic matter furnished the necessary material for the scales or plates of graphite in the limestones of northern New York. Silica provided the material for the limpid crystals of quartz found in the cavities of the Carrara marble of Italy. Silica may unite also with a part of the lime present, in the formation of such calcium silicates as wollastonite and scapolite. The hydroxides of iron may yield hematite or through reduction magnetite. The hydroxides of aluminum may form corundum or even ruby, the red gem variety of corundum, as in Burma. When both silica and alumina are present there occurs a reaction between them and a part of the calcium carbonate with the formation of several silicates of calcium and aluminum like garnet, vesuvianite, epidote, etc. The feldspars, micas, amphiboles and pyroxenes may appear along contact zones or as inclusions within the metamorphic limestone itself. Phlogopite is characteristic of many limestones or marbles that originally bore magnesia and silica in the presence of iron compounds. Magnesia alone may crystallize out as the oxide, periclase. When both magnesia and alumina are present spinel is formed. With magnesia and silica enstatite would appear. With magnesia, silica and iron minerals like olivine, bronzite, hypersthene, etc., appear. According to J. F. Kemp the Adirondack limestones were originally siliceous dolomites in which the silica and magnesia segregated as pyronenes.

Dolomite. The terms magnesian limestone, dolomitic limestone and dolomite are used more or less indiscriminately to designate any calcareous rock containing a high proportion of magnesium carbonate. Many dolomitic rocks have been classified as limestones when they contain more than 5 per cent of magnesium carbonate and less than 45.65 per cent of the same constituent. Such a rock should be spoken of as dolomitic.

As calcareous rocks approach the theoretical percentages of $CaCO_3$, $MgCO_3$, they constitute the true dolomites. In the mineral dolomite the calcium carbonate represents 54.35 per cent, and the magnesium carbonate 45.65 per cent. Dolomites often carry admixed calcite which in the analysis of the rock raises the calcium carbonate content above the theoretical percentage and correspondingly lowers the percentage of the magnesium carbonate.

The term superdolomite is often used to denote rocks with a large content of magnesium carbonate and a small content of calcium carbonate. This term would cease with less than 5 per cent of calcium carbonate and the rock would pass into the mineral magnesite, $MgCO_3$. In the magnesium rocks there is every gradation possible between the pure calcite, $CaCO_3$, on the one hand, and magnesite, $MgCO_3$, on the other.

Dolomites may occur either as an alteration product within a normal limestone or a chemically deposited rock. Many dolomitic rocks have originated from ordinary limestones by the introduction of magnesium carbonate from some external source. Dolomitization may occur while the fresh limestone or ooze is in the sea in which it is formed. This has been observed in the borings from coral islands. It is called contemporaneous dolomitization. Subsequent dolomitization may occur after consolidation and uplift of the original material into a land mass.

Waters bearing in solution magnesium carbonate as they traverse limestones exchange their less soluble magnesium carbonate for the more soluble calcium carbonate, molecule by molecule, and thereby the rock gradually becomes dolomitized. Recent experiments have shown that marine organisms secrete more magnesium than was formerly supposed. The leaching out of the more soluble calcium carbonate may occur, thereby

increasing the magnesium content without the introduction of magnesium carbonate.

Limestones and dolomites are sometimes interstratified and the successive layers are sharply differentiated from one another. Such a differentiation represents a primary difference in the materials deposited. This may be due to alternate chemical precipitation of limestones and dolomites, but in most cases the clastic origin of the rock must be postulated. In such cases the muds were derived alternately from calcareous and magnesian sources.

The limestones may also be of organic origin, and the dolomites derived from the erosion of dolomites forming a portion of the land mass. In such cases, the significance in alternation is no greater than that in limestones and shales. A secondary separation of a mixture of lime and dolomite grains by agitation of the waters and the unequal settling according to specific gravity is also possible.

Dolomitization may be produced by metasomatic replacement through the agency of ground water. Such waters are generally less effective than sea water, because the latter carries a larger percentage of magnesium carbonate in solution.

The magnesia for ground water circulation may be derived as carbonate from the decomposition of older dolomites or by the carbonation of many ferromagnesium minerals in the crystalline rocks.

Local dolomitization may be produced by contact metamorphism, as at Aspen, Colorado. This may be effected by hot magnesium-bearing waters rising through the limestone beds. When limestones have been intruded by peridotites such dolomitization may be expected. In the absence of the limestones, the transition may be to a siliceous magnesite, as in Troy, Vermont.

True chemical sediments occurring as dolomites are comparatively rare. The dolomite of Mansfield, England, falls into this class. Some of the oldest dolomites may be chemical precipitates. The dolomite of Ulm, Bavaria, is of fresh water origin.

According to F. W. Pfaff the products of organic decomposition, such as carbon dioxide, ammonium carbonate, ammo-

nium sulphide and hydrogen sulphide, play an important part in the process of dolomitization. Carbon dioxide acting for a considerable period of time upon the chlorides and sulphates of calcium and magnesium produces a double carbonate of the two bases. This condition is practically paralleled in the concentration of sea water. Therefore by this process dolomite may be formed.

F. W. Clark has suggested that algae may precipitate dolomite or the mixed carbonates as they do calcareous marl. Pressure may also promote dolomitization. It is apparent then that dolomites may be formed by various processes and possess different modes of occurrence.

Dolomite Tests. (1) Calcite effervesces freely in the presence of cold dilute HCl. Dolomite effervesces feebly under the same condition. Magnesite similarly treated should suffer no immediate change.

(2) When pure calcite is brought into solution with HCl and rendered ammoniacal, the calcium is completely precipitated out as carbonate by ammonium carbonate. The filtrate shows no additional precipitate with disodic phosphate. The magnesium of the dolomites is not precipitated by the ammonium carbonate, but is thrown down by disodic phosphate as magnesium ammonium phosphate.

(3) Calcite when treated with a solution of aluminum chloride and haematoxylin (extract of logwood) receives a violet coating. Dolomite under the same condition remains uncolored.

(4) Pulverize a few grams of rock suspected to be dolomite. Cover with water and add a few drops of phenolphthalein solution. Calcite gives a strong coloration. Dolomite is but slightly tinted.

Color. Limestones, marbles and dolomites possess a wide range of colors. They shade from pure white like the statuary marble of western Vermont to a jet black like that of Glens Falls, New York. The cream, buff, brown, orange and red tints are produced by varying amounts of the oxides of iron, either in a hydrated or anhydrous condition. The blue and some of the gray colors are produced by finely divided carbonaceous matter.

Clayey matter often presents a drab or gray appearance in a limestone, like many of the limestones of Kentucky. Iron disulphide in granules of microscopic size may produce a gray color. Uncombined carbon in the larger amounts produces a black.

Hardness. The hardness of the calcareous building stones varies widely. Calcite alone is only 3 in hardness. Statuary marbles possess the same degree of resistance to abrasion. The state of aggregation of the individual grains affects the hardness. The coquina of Florida, the coralline rocks of the reefs of many islands and the Caen marble of France are extremely soft. The Bowling Green oolite is of medium hardness. The siliceous limestones of Vermont are extremely hard and cut to a fine edge.

Specific Gravity. The specific gravity of limestones and marbles varies from 2.7 to 2.9. Its weight per cubic foot is a little higher than that of the average granite. With the higher specific gravity the weight would be 181 pounds per cubic foot.

Distribution. Some form of the calcareous building stones is found in nearly all states and practically in all countries of the world. Many of these are used only locally if at all. Some have found favor both at home and abroad. The Bedford, Indiana, oolitic limestone, the marbles of western Vermont and Carrara, Italy, fall into this class.

Age. The limestones, marbles and dolomites do not belong to any particular age. They are found in formations ranging from the Archaean to the Tertiary. The commercial limestones of Kentucky range in age from the Ordovician to the Carboniferous. Lime-bearing formations are accumulating at the present time.

Industrial Facts About Limestones and Marbles

Quarrying. In quarrying marble the object is to obtain large blocks of stone with the least disturbance possible. Where the sheets are too thick to split with wedges the channelling machine is used to cut vertical channels 2 inches wide and from 4 to 6 feet deep, depending upon the thickness of the block desired. This machine moves back and forth over the bed or floor of the quarry. The gadding machine drills holes in the

face of the block to one-half the breadth of the block desired. The stone may then be lifted with wedges. The blocks are subsequently split into smaller dimensions with wedges, or cut into slabs of varying thickness with a gang of saws. Emery and chilled iron are used to aid in the cutting. If possible, explosives should be avoided, as the sudden jar develops incipient fracture planes that aid in the disintegration of the stone.

Dressing. There are many different kinds of finish used for building stones before they are placed in their position in the wall of the structure. (1) In cobble houses either glacial erratics (in the northern portions of the United States), or angular fragments of rock from quarry products, are laid in the usual bond. These produce unique structures that are pleasing in their effect.

(2) *Rock Face.* Ashlar blocks are laid practically as they come from the quarry, having been trimmed to a unifrom size. Sometimes the stone is decorated with a margin of drove work.

(3) *Uniform Pointed.* These blocks are trimmed to correct dimensions and the outer face is then dressed with a pointing instrument. The stone is decorated with a margin of drove work.

(4) *Diagonal Pointed.* This stone differs only in facial appearance from the former, in that the pointing runs in diagonal lines at an angle of 45 degrees across the stone.

(5) *Square Drove.* The appearance of the face here is produced by a wide chisel with smooth edge. The lines through the center of the stone run parallel with the base of the block. The margin is decorated with drove work.

(6) *Toothed Chisel.* The toothed chisel produces in the center of the face a surface that somewhat resembles tapestry. The margin is decorated as in the previous cases.

(7) *Hammered Face.* Pean hammers, patent hammers and bush hammers produce different kinds of faces that are fairly smooth and somewhat resemble the pointed face finish. They are usually decorated with a margin of drove work.

(8) *Grooved Face.* The face of the stone here produces a grooved effect. The shallow grooves run across the entire face parallel with the bed.

(9) *Sawed Face.* In this case the blocks of stone are set as they are sawed out at the mill. Fine regular lines traverse the face.

(10) *Smooth Face.* The sawed stone is faced with a perfectly smooth unpolished surface. It may or may not have a margin of drove work.

(11) *Polished Face.* The sawed or chiseled face is rendered perfectly uniform and smooth by setting the entire block in a bed of plaster of paris and using in the order given, chilled iron, coarse emery, fine emery, diatomaceous earth and putty powder or oxalic acid. When oxalic acid is used in the process of polishing the expense and time element are less, but the polish is short lived. Many decorative marbles and granites in our cemeteries that now appear dull owe this condition largely to the use of oxalic acid in the process of buffing. Putty powder, which consists largely of the oxide of tin, produces a more expensive, more lasting and far more satisfactory polish.

(12) *Hammered Finish.* The cost of finishing stone is determined partly by the shape and largely by the smoothness of the surface desired. The stone is finished by beating it with hammers containing blades set at various widths. The number of blades to the inch determines the fineness of the surface that can be secured.

For step work, approaches and the upper stories of high buildings, four cuts to the inch give a satisfactory finish. Four-cut work is specified by the United States Government for post-office base courses. Many commercial buildings are made in this finish.

Six-cut work is the standard for bank fronts, private residences, state capitols, city halls, railroad terminals, art museums, fine bridges, and in general the better class of public and private buildings.

Eight-cut work is often specified on large public memorials, elaborate bank and building entrances, garden work, fountains, mausoleum roof stones and elevated statuary groups.

Ten-cut finish is generally used on monuments, mausoleums, statuary, and other work which demands a special smoothness

of surface. Good stone with ten-cut bushing shows a surface smooth as velvet and free from imperfections.

Uses. The limestones are used in the manufacture of white lime or tinted limes. A larger percentage of limestone proper goes into this field than all other uses combined. This lime product finds use not only in structural work but in the beet sugar industry. Limestones are used for building purposes when they are of fairly uniform color and texture. They are used sometimes for paving blocks, but are not resistant to abrasion, and for curbings and gutters. They find large use as a flux in the treatment of iron ores and in the manufacture of the numerous grades of Portland cement. They are used also as a fertilizer and in the manufacture of glass.

The marbles find their largest uses in structural and monumental work. The decorative marbles are used for pillars, colonnades, wainscoting, panels, baseboards, flooring, tiling, fire-jambs, lintels, counters, shelves, clocks and table tops. The beauitful onyx marbles find use not only for decorative interior work but also in soda fountains, shelves, table tops and clocks.

Compression Tests. The average strength of marbles is not as great as that of granite. Good structural work should resist from 12,000 to 18,000 pounds to the square inch. Some friable marbles fall under these figures and many good marbles exceed them. In nearly all cases they are far above the strength required, even with the builders' margin of safety added to the superincumbent weight. The compression strength of limestones and marbles varies from 3,550 pounds per square inch for the limestones of Caen, France, to 25,000 pounds for the Champlain marble of Vermont.

Polished Specimens of Kentucky Limestones and Marbles

The numbers here given corespond with the numbers on the polished specimens placed on exhibition in the rooms of the Kentucky Geological Survey, Frankfort, Kentucky.

5. White oolitic limestone, White Stone Quarry, Bowling Green, Ky.
11. Dark gray limestone, Glasgow, Ky.
13. Brown cedar limestone, Glasgow, Ky.
32. Dark gray marble, Danville, Ky.

33. White limestone, Reservoir Knob, Somerset, Ky.
34a. Medium gray marble, Reservoir Knob, Somerset, Ky.
34b. Medium gray crystalline marble, Reservoir Knob, Somerset, Ky.
37b. Crystalline oolitic limestone, W. J. Sparks quarry, Rockcastle, Ky.
43. Dark gray limestone, Winn quarry, Mt. Sterling, Ky.
46. Grayish white marble, Slaughter House quarry, Georgetown, Ky.
47b. Medium gray marble, Sumers quarry, Georgetown, Ky.
48. Pink marble, Paris, Ky.
49. Dark gray marble, Poindexter quarry, Cynthiana, Ky.
50a. Pink marble, Quincy Ward quarry, Cynthiana, Ky.
50b. Pink marble, Quincy Ward quarry, Cynthiana, Ky.
52. Dark gray marble, Maysville, Ky.
54. Dark gray marble, City quarry, Flemingsburg, Ky.
57a. White crystalline oolitic marble, Silman quarry, Stephensburg, Ky.
59. Dark gray massive limestone, Leitchfield, Ky.
61a. Oolitic limestone, Katterjohn quarry, Cedar Bluff, Ky.
61b. White oolitic limestone, Katterjohn quarry, Cedar Bluff, Ky.
62. Hard gray limestone, Lyon quarry, Eddyville, Ky.
65. White oolitic limestone, Cook quarry, Hopkinsville, Ky.
69a. Grayish white marble, Estes quarry, Lebanon, Ky.
71. Mottled limestone, Circassian walnut, Bardstown, Ky.

SAMPLES POLISHED IN AUGUST, 1922

49a. Dark gray marble, Poindexter quarry, Cynthiana, Ky.
50c. Pink marble, Quincy Ward quarry, Cynthiana, Ky.
61c. Banded oolitic limestone, Katterjohn quarry, Cedar Bluff, Ky.
78. Dark gray marble, Hamilton quarry, Lexington, Ky.
79. Medium gray marble, Headley quarry, Lexington, Ky.
81. Medium gray marble, Work House quarry, Frankfort, Ky.
82. Light gray banded marble, Blanton quarry, Frankfort, Ky.
83. Mexican onyx, Cave City, Ky.
84. Mexican onyx, Cave City, Ky.
85. Mexican onyx, Horse Cave, Ky.
86. Mexican onyx, Horse Cave, Ky.
87. Peridotite, Elliott County, Ky.

CHAPTER V.

DESCRIPTION OF MICROSCOPIC SLIDES

Mr. Ralston G. Sprague, Teaching Fellow in Mineralogy at Syracuse University, kindly assisted the author in the detailed study of the slides described in this chapter.

No. 1, No. 19, Ky. G. S. This rock was labeled in the field a micaceous quartzite. It was collected at Cannonsburg, Boyd County, Kentucky, July 12, 1921.

Under the microscope the slide consists of calcite surrounding a large number of quartz grains, orthoclase, microcline and albite. The quartz grains are in part well rounded, but the most of them are fairly large and angular, suggesting residual quartz. There are also present muscovite, chlorite and carbonaceous material.

The calcite is granular and for the most part well crystallized. It is the interstitial material surrounding the grains of the other minerals. Nowhere in the slide is there any large isolated mass of calcite.

The quartz is slightly more abundant than the calcite. Its rounded, subangular and angular grains show little if any evidence of quartz secondarily introduced or of the recrystalization of the quartz due to metamorphism. There are a few pebbles of well crystallized quartzite in the slide. This evidences that the well-rounded quartz grains come from the decomposition of some unknown quartzite.

Of the feldspars, microcline is by far the most abundant. It shows the characteristic grating structure. The orthoclase is somewhat kaolinized and microperthitic. The albite was twinned according to the albite law.

In the slide the muscovite occurs as a few small flakes or plates, but in the hand sample the mineral is a prominent constituent arranged somewhat more abundantly along cleavage planes in the rock.

The chlorite is present as one or two individuals which show green pleochroism. It is secondary in origin and was probably derived from scales of biotite. The carbonaceous matter is not abundant, but uniformly distributed.

The rock is best classified as a calcitic arkose. An arkose is a feldspathic sandstone. The Cannonsburg arkose appears to have been derived largely from the residual products of a muscovite granite low in its biotite content. The home of this granite was not far from Cannonsburg, and arkoses are not distributed over large areas.

Oolitic Limestone

No. 2. The rock from which this slide was cut came from the Green River quarry, Bowling Green, Warren County, Kentucky. It is an oolitic limestone.

This slide is made up entirely of crystallized calcium carbonate, $CaCO_3$. The section is a mass of rounded and in some cases elongated semi-opaque oolites surrounded by interstitial calcite. A part of the calcite is crystallized so that it shows interference colors, but the remainder of the calcium carbonate is in so fine granules that it does not show any extinction angles or interference colors. No other mineral constituents are present, save a very small amount of carbonaceous matter scattered uniformly through the slide.

The oolites are either rounded or elongated and semi-opaque. The border of the mass is usually lighter than the center, and some of the oolites show a radial structure. The whiteness of color, the uniformity of texture and the freedom from limonite stains in the oolites makes this rock one of the most valuable building stones of Kentucky. The rock is a crystalline oolitic limestone.

Crystalline Limestone

No. 3, No. 57a, Ky. G. S. This slide was cut from the white crystalline limestone of Silman's quarry, Stephensburg, Hardin County, Kentucky. It was collected August 20, 1921.

This slide is similar in many respects to Slide No. 2. It consists entirely of calcium carbonate, $CaCO_3$, with a very little carbonaceous material. There is a large number of oolites surrounded by fine grained calcite. Some of the oolites show a concentric growth with a nucleus of calcite, others are uniform throughout, while still others have the concentric arrangement with a slightly opaque and a more dense center.

Within the slide there are apparently fossil forms. Some of them show a distinct basal growth of alternating transparent and semi-transparent bands. Still other forms have the appearance of corals. In this slide there are a few well-formed crystals of calcite of considerable size which have good extinction angles and show brilliant colors.

It is not sufficiently well crystallized to be called a marble mineralogically. Therefore the term crystalline limestone is the most appropriate. Its freedom from iron makes it a very desirable building stone.

Dark Gray Marble

No. 4, No. 49, Ky. G. S. The sample of dark gray marble from which this slide was cut was taken from the Poindexter quarry, Cynthiana, Harrison County, Kentucky, August 10, 1921.

The slide is composed of calcium carbonate, $CaCO_3$, with very small fragments of carbonaceous matter. The few oolites present are considerably broken and fractured. There are a number of rounded forms which differ from the oolites in not having the concentric structure. These doubtless represent some fossil forms.

The calcite is much better crystallized than it is in Nos. 2 and 3. A few of the grains show fine rhombohedral cleavage. Most of them have the fine grained granular appearance without any visible cleavage. The rock is sufficiently crystallized to be classed as a marble, for it represents a metamorphosed limestone. It is susceptible of a high polish and the carbonaceous matter imparts the dark color to the stone.

Grayish White Crystalline Marble

No. 5. The sample from which this slide was cut was collected at Sumers' quarry, Georgetown, Scott County, Kentucky, August 8, 1921.

This slide consists of crystallized calcium carbonate, calcite, $CaCO_3$, with a very small amount of carbonaceous material, but not in sufficient quantity to impart much color to the rock. The slide is fine grained and granular. In fact, it is made up of rounded and sub-angular grains of calcite so fitted together as

to form a mosaic. In part the crystals of calcite are sufficiently large for a few of them to cover the entire field under the microscope.

Although the calcite is well crystallized the alteration has not been sufficient to obliterate all oolites and apparent fossil forms. The principal fossil form consists of a series of snake-like ribbons or bands crossing the section.

The calcite is so well crystallized in some cases that it shows striations in polarized light and brilliant interference colors. These features are very noticeable in this section.

White Crystalline Limestone

No. 6, No. 10, Ky. G. S. This sample was collected from the J. W. Sparks quarry, Russellville, Logan County, Kentucky, June 30, 1921.

The section consists largely of oolites and ribbon-like masses. Some of the oolites have a dark border with homogeneous center, while others show concentric structures. Most of the calcium carbonate is entirely uncrystalized. Only a small amount of interstitial material surrounding the oolites, and the centers of a few of the oolites, show crystallization. The section contains some peculiar rod-like forms which may be elongated oolites. Very little carbonaceous matter is present. The rock is a very fine grained, pure, semi-crystalline limestone well suited for constructional and monumental work.

Grayish White Marble

No. 7, No. 69a, Ky. G. S. The sample from which this slide was cut came from the Estes quarry, Lebanon, Marion County, Kentucky. It was collected September 1, 1921.

This slide shows a fine grained aggregate of calcite, $CaCO_3$, with a few fairly large patches of calcite, a few oolites and similar features. The slide shows a peculiar structure which has the appearance of some sort of flowage action or movement among the minerals during crystallization. The oolites are not abundant and some of them appear displaced. The fairly large areas of well-crystallized calcite, when viewed under high power, are clearly seen to be made up of a very fine grained aggregate of

calcite crystals. There is apparently some dolomite in the rock as there is a mineral present which develops good rhombohedrons that have a higher index of refraction than the surrounding medium.

A slight trace of carbonaceous material imparts the grayish white color to the marble. The rock is a recrystallized limestone, and therefore a marble mineralogically. It is an excellent building stone.

Oolitic Limestone

No. 8, No. 61, Ky. G. S. This sample came from a bed of white oolitic limestone varying in thickness from 16 to 20 feet, and traversed by zigzag bands of colored material. It also came from the Katterjohn quarry, Cedar Bluff, Caldwell County, Kentucky, and was collected August 25, 1921.

The microscope reveals the rock to be a limestone made up of oolites and other similar formations. The essential mineral is calcium carbonate, $CaCO_3$, but for the most part it is not crystallized and the section is semi-transparent.

The oolites are rather large and show the concentric growth very well. Some of them have a crystallized nucleus. A few crystals with strong birefringence are scattered through the mass and occur mostly as interstitial material around the oolites. The rock is an oolitic limestone capable of wide industrial application. Its absolute freedom from iron is noteworthy.

Birdseye Limestone

No. 9, No. 29, Ky. G. S. This sample of birdseye limestone came from Tyrone, Anderson County, Kentucky. It was collected July 22, 1921.

Under the microscope the section shows a very fine grained, granular, semi-opaque ground mass containing a small amount of anisotropic mineral in crystalline aggregates, an occasional eye or rounded mass of calcite resembling a well crystallized oolite and numerous small rhombehedral crystals, sometimes making up half of the field. The section is homogeneous except for the features noted, which are evenly distributed through the mass. Occasional black or brownish black opaque specks are scattered through the section. These are probably carbonaceous

material. They are not in sufficient abundance to impart definite color to the rock. The fine grained ground mass will not give any resemblance of an interference figure showing its noncrystalline character. The rhombohedrons are uniaxial and negative, proving them to be calcite, $CaCO_3$.

The rock is a fine grained, semi-crystalline limestone or marble, free from iron. It is therefore a very valuable building stone.

Mottled Marble

No. 10, No. 71, Ky. G. S. This sample is a mottled limestone containing many zigzag lines of colored material. It came from Bardstown, Nelson County, Kentucky, and was collected September 3, 1922.

Under the microscope the section shows a medium grained, granular, well-crystallized aggregate of calcite. Some of the grains are rather irregular, but a large number of them have developed into regular symmetrical rhombohedrons.

The section contains a few scattered grains of quartz which are quite small as compared with the calcite. All of them are well rounded, as if by water action. There is in the slide a small fragment of a green mineral which is rather peculiar. It shows no cleavage, is not pleochroic, and has a rather low order of birefringence. Its index of refraction is about the same as that of calcite, and it contains fragments of calcite. Under the high power, the mineral appears scaly, with a bluish interference color. It is probably chlorite. There is also present a second fragment of a mineral which conforms in optical properties to chlorite. There is also present a single crystal of biotite, partly chloritized. The chlorite was therefore derived from biotite. The rock is a marble mineralogically. It is well suited for industrial work.

Dark Gray Crystalline Marble

No. 11. This sample of dark crystalline marble came from Norwood, Pulaski County, Kentucky. It was collected July 26, 1921.

This slide shows a crystalline aggregate of calcite with numerous oolites and fossil forms. Some of the oolites are

stained with limonite, which gives them a reddish or yellowish brown tinge. The crystals of calcite show high interference colors, and in many cases twinned striations. All of them show good cleavage, which is so characteristic of true calcite.

The fossil forms are quite numerous. Some look very much like the cross-section of a plant stem or a crinoid, while others more closely resemble a longitudinal section of the same plant or crinoid. These fossils are quite abundant. The oolites do not appear to have been disturbed by crustal movements.

In this slide there are numerous well-rounded grains of quartz. Some of these are within the oolites and some occupy interstitial spaces among the oolites and the calcite. There is also a little carbonaceous matter present, which imparts the dark gray color to the rock. This marble is susceptible of a high polish, and is better suited for decorative interior work than it is for constructional purposes.

Dark Gray Crystalline Marble

No. 12. The sample from which this slide was cut came from the Smith quarry, Georgetown, Scott County, Kentucky. It was collected August 8, 1921.

Under the microscope this slide shows a granular aggregate of crystallized calcite with a very few oolites. Most of the calcite is well crystallized. The larger crystals show characteristic striations. In some portions of the slide the entire material of the original limestone has been recrystallized, while in other portions the crystillization is not quite complete. The finer and more granular portions do not show good crystallographic development, but the well developed larger crystals give perfect interference figures, and show typical calcite cleavage.

There is present a very small amount of carbonaceous material, to which the dark color of the rock is due. This color may be intensified by a very slight limonite stain concentrated in the vicinity of the oolites. There are in this slide a very few well-rounded quartz grains.

The rock as a whole appears to be sufficiently crystallized to be classed as a marble. It is susceptible of a high polish, and well suited for decorative interior work.

Dark Gray Marble

No. 13, No. 54, Ky. G. S. This sample came from the City quarry, Flemingsburg, Fleming County, Kentucky. It was collected August 15, 1921.

Under the microscope this slide shows a granular aggregate of calcite crystals, with many oolites and fossil forms. The oolites and fossil forms are more abundant than they are in slide No. 12. The crystallization is not complete for the entire slide, but there are many rhombohedrons which show good calcite cleavages and give interference figures. In some sections the calcium carbonate of the original limestone is completely crystallized, while in others it remains a granular, semi-opaque mass. There are also in this slide a very few grains of well-rounded quartz. The carbonaceous matter is insufficiently abundant to impart the dark gray color to the rock.

The rock is a semi-crystalline limestone or marble sufficiently crystallized to receive a high polish, and well suited for interior work.

Bluestone

No. 14, No. 15, Ky. G. S. This sample came from the quarry of the Kentucky Bluestone Company, Bluestone, Rowan County, Kentucky. It was collected July 8, 1921.

Under the microscope the slide is shown to be a clastic rock. The principal constituent is quartz, which occurs in small rounded or subangular grains. The other minerals present are feldspars (species not known), muscovite, sericite, biotite, cholrite, calcite and zircon.

Quartz is by far the most prominent mineral in the slide. The grains are quite uniform in size and well water-worn, as if they represented a transported sediment.

The other minerals present are scattered through the slide as isolated fragments. They are all well rounded and quite small. Scattered through this slide there are some rounded opaque grains, which are white or yellowish white in color when seen by reflected light. The identification of these grains is not certain. However, there are two or three possibilities that suggest themselves. They resemble lucoene, but there are no accompanying fragments of ilmenite from which they may have been derived.

Kaolinite suggests itself as a possibility, also turgite, but both of these are very doubtful.

The rock has evidently undergone some alteration, as is evidenced by the presence of scaly sericite and the limonite stains. There is no evidence of the recrystallization of the sand grains. Therefore the rock is best cataloged as a sandstone with calcium carbonate and clayey matter as the cements binding the sand grains together.

This sandstone is so fine grained and even textured that it is a valuable constructional stone.

Sandstone

No. 15, No. 42, Ky. G. S. The sample of fine grained sandstone from which this slide was cut came from the Langford quarry, Rockcastle County, Kentucky. It was collected July 29, 1921.

This slide is composed of small angular grains of quartz together with a considerable quantity of fine sericite scales and scattered grains of chlorite, muscovite, limonite, zircon, apatite and leucoxene, an alteration product of elmerrite.

The grains of quartz are a little more angular and a little more irregular in size than they are in the sample from Bluestone. The accessory minerals are present in similar proportions to those in the Bluestone sample. The light colored opaque mineral taken to be leucoxene is present in this section in numerous well-rounded grains. The rock is a sandstone with clayey matter serving as the cement. It is a valuable constructional stone.

CHAPTER VI.

EASTERN KENTUCKY

The area embraced in Eastern Kentucky includes all the eastern part of the State and the Knobs adjacent to the region. Many of these Knobs border the Bluegrass section on the east. The western boundary may be marked by a line drawn approximately north 45 degrees east through Clinton, Wayne, Pulaski, Rockcastle, Estill, Powell, Menefee, Rowan and Lewis Counties. The last county mentioned borders the Ohio River. The counties will be listed in this chapter in alphabetical order, whether visited in the field work or not visited for lack of time. This arrangement will aid materially in finding information concerning the building stones of the various counties.

Bell County

The building stones of Bell County are essentially sandstones of Pennsylvanian age. Ten quarries either active or abandoned were located within the county. The striking exception to the sandstones is found in the Jack Asher quarry.

(1) The Jack Asher quarry is situated about 30 rods south of the Louisville & Nashville Railroad station at Pineville, the county seat, where by the Pine Mountain fault, with displacement of 1,500 feet or more, the upper Mississippian limestone has been brought into view. The quarry opening is approximately 200 feet in length, 100 feet in width, and the quarry face was estimated 100 feet in height.

The uppermost beds are of sandstone, which is not regarded as good for building purposes.

The upper portion of the limestone beds comprises about 40 feet of well crystallized limestones, reasonably free from chert nodules. This would make a fairly satisfactory building stone. The lower 50 feet consists of a dark gray semi-crystalline limestone with chert nodules more or less scattered through the stone. The cherty limestones elsewhere in the State have been used for constructional work.

(2) The Joseph Smith quarry, operated by Tom Caton, is situated within the city limits, one-fourth of a mile north of the Continental Hotel. It is a bluish sandstone which weathers

dark on exposure to the atmosphere and is said to be the stone used in the stone front next to the Bell National Bank.

(3) This quarry is situated within 300 yards of the Louisville & Nashville freight depot. A quarry has been opened at the south end of a bluff extending north and south along the railroad. The stone is slightly bluish gray, very fine grained, and somewhat micaceous. It appears a little softer than the stone at the north end of the same bluff. The stone is used for building purposes.

(4) At the north end of the same bluff there is an abandoned quarry of bluish gray, fine grained, slightly micaceous sandstone that would make a most excellent building stone. It is free from iron, hammers white, and is very pleasing in its effect. A quarry opening 1,000 feet in length of working face, with height of 50 feet, could easily be effected. Some of the beds are more than 10 feet in thickness, without seam or flaw.

(5) Near where the Louisville & Nashville Railroad crosses Bennett's Branch just north of the Kentucky-Tennessee State line there is a small quarry of fine grained, micaceous sandstone of good quality. This quarry is about 3 miles southwest of Middlesboro.

(6) This quarry is located near the mouth of Bearfork Branch of Stony Fork some 2 miles west of Middlesboro. This stone is fine grained and micaceous.

(7) This quarry is situated near the mouth of Hignite Creek about 4 miles west of Middlesboro and just to the north of a branch of the Louisville & Nashville Railroad. The stone appears the same as in No. 6.

(8) This quarry is located on Stony Fork, 5 miles west of Middlesboro. The stone for the American Association building in Middlesboro came from this quarry.

(9) There is a small quarry 10 miles west of Middlesboro near the junction of Clear Fork and Sowder Creek. The stone for the piers and abutments of the Louisville & Nashville bridge over Clear Fork came from this quarry. The stone is of pinkish color, of medium grain, and weathers well.

(10) This quarry is situated near the junction of Brown's Branch and Yellow Creek about 3 miles north of Middlesboro.

It is close to the Louisville & Nashville Railroad on the State road from Middlesboro to Pineville. It is therefore the most accessible of all the quarries of the lower half of Bell County. The stone is fine grained, bluish gray, and should be used for building purposes.

The front of the Exhibition Hall and Library at Middlesboro is of local stone. Local stone is also used in the Citizens Bank & Trust Building, the Coal, Iron & Bank Building, and in many foundations and walls.

Boyd County

The outcrops of sedimentary rocks listed as quarries or quarry prospects are all in sandstones of Pennsylvanian age. Nine such quarries are listed within the county. Five of them are just southwest of the Chesapeake & Ohio Railroad and only

1. ASHLAND RAILROAD STATION.
Station on the Chesapeake and Ohio Railroad at Ashland, Boyd County, Ky. It was built of Rowan County freestone.

a few rods to the southwest of the Ohio River. The other four are situated to the east by southeast of the Louisville Division of the Chesapeake & Ohio Railroad, and strictly speaking are quarry prospects.

(1) The quarry of the Ashland Cement & Construction Company is 1 mile northwest of Ashland. The stone is of dark bluish gray color, micaceous, of medium texture, and somewhat banded. It has been used to quite an extent in construction work.

(2) The John Paul Jones quarry is situated 1½ miles northwest of Ashland in the same range of bluffs as No. 1. The stone in the Christian Science Church on Seventeenth Street, Ashland, came from this quarry, more than twenty-five years ago. The quarry is now abandoned, although much good stone can be obtained at this site.

(3) This is an abandoned quarry 3 miles northwest of Ashland. Stone was quarried here some 17 or 18 years ago for the coke ovens of the Ashland Iron & Mining Company.

(4) At the Cliffside Bluffs, 2 miles south of Ashland, there is a very massive, somewhat bluish gray, slightly micaceous sandstone which occurs in beds several feet in thickness. A quarry could easily be opened here, with a 50-foot working face. Furthermore, such a quarry would be only a few rods from the railroad for shipping the quarry products. A little further to the west on this line of bluffs there are sandstone exposures with individual beds from 10 to 20 feet in thickness that should make a very good building stone. Stone was quarried at Cliffside several years ago for a dwelling in Ashland and has given very satisfactory results. This sandstone is the Homewood.

(5) This quarry is situated within the city limits of Catlettsburg, the county seat. It is a massive, thick bedded, bluish gray, micaceous sandstone that is fairly well suited for constructional work. The numerous spalls from this quarry show few if any ill effects of weathering. The quarry is abandoned because of the close proximity of dwelling houses.

Overlying the bluish gray, massive sandstone there is often 15 to 20 feet of a cream-buff colored, medium grained sandstone that appears to have never been opened up back of the zone of weathering. An analysis of a surface sample gave 89.55 per cent of SiO_2 and 1.12 per cent of ferric oxide. How much of the iron content may have resulted from surface weathering is not

known. It should make a fairly satisfactory building stone with a judicious selection of the blocks.

(6) This quarry possibility is situated a little south of Summit Herd. The rock is a white to creamy white, medium grained sandstone, occurring in beds of merchantable thickness.

(7) This quarry possibility occurs at Princess. It is in the same white or yellowish white, medium grained sandstone formation as No. 6.

(8) A cut made in the construction of the permanent roads over Laurel Hill was made through a more or less massive, bluish gray, fine grained and micaceous sandstone that is of especial interest in view of the character of the sandstone near Cannonsburg.

(9) This cut was made in the construction of a permanent road from Ashland to Cannonsburg. This sandstone is very hard, compact, calcitic, micaceous and arkosic. The calcite is for the most part well crystallized and is the interstitial material surrounding the grains of the other minerals. The few well-rounded quartz grains have been derived from the decomposition of an unknown quartzite, which appears as microscopic pebbles in the rock. The most of the quartz grains are large and angular, suggesting residual quartz. This angularity is so pronounced that it is evident to the observer that the material could not have suffered transportation to any considerable distance.

The angularity of the large quartz grains, the abundance of the feldspars, orthoclase, microcline and albite, the numerous scales of muscovite, arranged somewhat in parallel layers in the hand samples, together with the paucity of biotite crystals, suggests that the rock was derived from a muscovite granite low in its biotite content. If the evidence is correctly translated, then this arkose has written a new chapter in the geologic history of Kentucky. Granitic intrusions of unknown age invaded sediments of unknown age, possibly Cambrian, which suffered erosion of probably 5,000 feet of overlying strata before Mississippian time. The granite mass may have been an island during Mississippian and early Pennsylvanian time, and the

sediments comprising the arkose deposited upon its flanks and crest near the close of the Pennsylvanian in Kientucky.

As this type of rock has not been found before in Kentucky, the formation is named the Cannonsburg Arkose. Detailed field work and much petrographic study is necessary to determine the extent of the formation. It is not expected to prove extensive.

The massive portions should make a good building stone, and the whole formation a most excellent road stone. For a description of this rock in detail see Slide No. 1 in Chapter V, which is the same as Sample No. 19 of the Kentucky Geological Survey.

Samples of limestones that should have commercial possibilities were submitted to the author from the east of Poorhouse Fork, East Fork and north of Boles Fork.

Breathitt County

There is a quarry near Jackson in yellowish brown sandstone. The stone is used for building purposes around Jackson, the county seat.

Carter County

There are 11 quarries located in Carter County, mostly in limestone of Mississippian age. Seven of the quarries are located along the Chesapeake & Ohio Railroad. The limestones are with one exception non-dolomitic.

(1) This quarry is situated at Highland, near Enterprise. It is owned and operated by the Olive Hill Limestone Company. The limestone is massive, with some beds bluish gray and others nearly white in color. It is siliceous and contains some clayey matter. The calcium carbonate content is 50.00 per cent, and the magnesium carbonate reaches 21.36 per cent. It is therefore strongly dolomitic, but the magnesium carbonate is not sufficiently high for the rock to be classed as a true dolomite.

(2) This quarry is situated at Lawton. The individual beds sometimes reach a thickness of 4 feet. The stone ranges in color from a grayish white to nearly white. The rift and grain of the stone are good. The calcium carbonate content

is 96.28 per cent, and according to the chemist of the Libby-Owens Glass Company of Toledo, Ohio, there is no magnesium carbonate present, and only a faint trace of iron oxides. The stone should therefore weather well, and make with judicious selection a very satisfactory building stone.

(3) This quarry is located at Limestone. It is owned and operated by the Olive Hill Limestone Company. The quarry is about 500 feet in length, 200 feet in breadth, and 65 feet in depth.

The limestone is hard and breaks with a conchoidal fracture. It is somewhat metamorphosed, for it carries narrow veins with crystals of calcite. The iron oxide content is only 0.48 per cent, and the clayey matter is very low. It is non-dolomitic.

(4) This quarry is about 1 mile east of Olive Hill on the north side of the railroad. It is owned and operated by the Olive Hill Limestone Company. It is some 800 feet in length, 200 feet in breadth, with a working face of approximately 83 feet. Some of the beds are 22 feet in thickness. Some of them are quite crystalline and would make a very good building stone. This holds especially true in the lower portions of the quarry. A few of the thinner beds contain much clayey matter, and neither wear nor weather well. This quarry formerly belonged to the Atlas Stone Company.

(5) This quarry is situated on the south side of the railroad about one-fourth mile from No. 4. It is known as the Highland quarry. The characteristics of the limestone at this quarry are the same as at No. 4, and the entire output is used as crushed stone for road building, railroad ballast, street work and the construction of the Midland Trail.

This quarry extends into the hill to the south, while No. 4 extends into the hill to the north. Each with an increasing depth of working face.

(6) This quarry is at Grayson, the county seat of Grayson County. It is reached by the Eastern Kentucky Railroad extending north from Hitchings. According to D. S. L. Warnock, contractor and builder, Grayson, Kentucky, the quarry

possibilities are large, and the stone is used locally for building purposes.

(7) This quarry is located at Carter. It is reached by a spur of the Chesapeake & Ohio Railroad from Garrison. There is a large crusher here, and the stone is used along the Chesapeake & Ohio Railroad.

(8) This quarry is located about 1 mile west of Carter by the spur of the Chesapeake & Ohio Railroad. The stone is like that in quarry No. 7.

(9) This quarry is situated on the John B. Gregory Estate, now owned by Harriet Gregory Barney, about 5 miles from Grayson and 10 miles from Olive Hill. The quarry was opened up to furnish stone for bridges, culverts, and construction of the Midland Trail. This stone is one of the best in eastern Kentucky. It is a grayish white in color, fine to medium grained, oolitic in texture, and semi-crystallized. It is an excellent building stone.

(10) This quarry is in sandstone rather than limestone, and is situated at Lawton. The quarry is owned by the Camp Glass Company of Huntington, West Virginia. The purer beds are from 2 to 4 feet in thickness, white or yellowish white in color, and with little cementing material binding the sand grains together. The percentage of quartz sand is 99.45 with only 0.04 per cent of iron oxides. It is not impossible, as the quarry is carried back further into the hill, that good building stone may be found.

(11) The General Refractories Company of Olive Hill operate a small quarry of sandstone which is situated about one-half mile west of their factory. The lower 15 feet in the quarry is white or faintly yellowish white in color, but too brittle for constructional work.

Along the Chesapeake & Ohio Railroad between Grahn and Leon there are huge bluffs of a massive yellowish white sandstone. Some of the beds are 25 to 50 feet in thickness. They are Pennsylvanian in age. It could not be ascertained that any quarrying had ever been done in this section. The area is worthy of investigation.

Near Willard there are high bluffs of massive sandstone that would make a very good building stone. Apparently blocks of considerable dimensions could be secured here.

Clay County

According to Philip G. Russell, in his Report on the Coals of Sexton Creek, sandstones of Pennsylvanian age, Lower Pottsville, are widely distributed in Clay County. The sandstones are fine grained and massive, save the sandstone overlying the Burns Coal, which is massive and medium to coarse grained. The sandstones underlying the Manchester coal are often cross-bedded. The sandstones of Clay County range in color from white to grayish white, and should be well adapted for local construction.

According to James M. Hodge in his Report on the Coals of Bullskin and Redbird Creeks, the same Pennsylvanian sandstones as mentioned above sometimes attain a thickness of 50 feet in this region. Distance from point of shipment is against a wide use of these products, but they should be used locally in constructional work, and probably have been used around Manchester, the county seat.

Clinton County

This county was not visited by the author on account of its general inaccessibility by rail. The reader is therefore referred to The Geology of Clinton County by R. H. Loughridge for the discussion of the different terranes within the county.

According to the State Geologic Map the rocks are nearly all Mississippian, with a tongue of the Pennsylvanian system extending into the county to the northeast of Albany, the county seat. There are also several outliers of Pennsylvanian rocks apparently forming the crests of the Knobs. The total thickness of rocks exposed in the county is 1,300 feet. Many of the sandstones are massive and of greenish color, possibly due to chlorite, possibly to glauconite, and some of them are micaceous.

According to information received July 10, 1922, three are five quarries within the county. They are all in the limestones of Mississippian age.

(1) *Albany Quarry.* This quarry is situated just north of Albany, and furnished the stone for the foundation of the courthouse. The stone is of light blue color and weathers well.

(2) *Graded School Quarry.* This quarry is situated just east of Albany and furnished the stone for the foundation of the graded school. It also furnished the stone for the foundation of several churches and dwellings.

(3) This quarry is some 4 miles west of Albany on the Albany-Cartwright-Monticello Pike. It has furnished much blue and gray limestone for road work. The beds are from 1 to 2 feet in thickness and massive.

(4) This quarry is on Guinn Mountain, formerly called Poplar Mountain, and is some 6 miles from Albany. Here the oolitic and semi-oolitic limestones attain a thickness approximating to 150 feet, and should furnish much excellent building stone for local uses.

(5) Some 4 miles north of Albany toward Seventy-six there are many thick beds of massive limestone of blue to bluish gray color that could furnish good building stone.

Elliott County

The terranes of Elliott County are prevailingly of sedimentary origin, save the small area of peridotite dikes in the eastern part of the county. The sedimentaries all belong to the Pennsylvanian system (Pottsville), save a small area of Mississippian limestone (Lower Carboniferous) in the northwestern part of the county, a few miles to the southeast of Limestone in Carter County.

The sandstones are massive, of bluish gray and yellowish white color, and sometimes furnish beds 50 feet or more in thickness. It should contain beds sufficiently pure for local use, and it probably has been used in Sandy Hook, the county seat.

Elliott County is one of the four counties of Kentucky invaded by intrusives. These basic igneous rocks occur as dikes in the hills on each side of Ison Creek just west of Stephens in the eastern part of the county. They came from the zone of flowage in the interior of the earth, but did not flow out over

the surface as lava. The area traversed by these dikes covers only a few acres, and all of the isolated masses may logically be considered parts of a single intrusion, for they are identical in mineral composition.

The peridotite presents somewhat the appearance of a breccia, for angular fragments of shale, sandstone and limestone are encased within it. The amount of metamorphism that has taken place in these inclosed fragments is surprisingly little, showing that the magma from which the peridotite formed had cooled nearly to the point of solidification when it gathered up these fragments of invaded rocks. High temperatures would have favored the resorption of the inclusions.

The specimens studied by the author are grayish black in color and porphyritic. The phenocrysts are fresk olivine, with edges rounded as if resorbed by the magma after their crystallization. Enstatite, biotite, and the garnet, pyrope, are very abundant. Ilmenite and apatite are present.

Peridotites alter readily. The iron is the first to go. It yields magnetite. The magnesium silicate takes up water, and the hydrous silicate of magnesium, serpentine, results. In the presence of carbonated waters magnesite may form. In their absence some free silica may be derived. In the presence of calcium bearing pyroxenes, some calcium carbonate, calcite, or calcium and magnesium carbonate, dolomite, will result. In the process of the serpentinization of olivine there is an expansion of from 12 to 14 per cent and much fracturing occurs. The fracture planes may be filled with calcite, dolomite, or magnesite. The massive rock is then known as verd antique marble, which is susceptible of a high polish, and well suited for decorative interior work. A polished sample of this rock can be seen in the museum of the Geological Survey at Frankfort.

The mineral composition of this peridotite is so closely related to that of the diamondiferous Kimberlite of South Africa that J. S. Diller of the U. S. Geological Survey has named it Kimberlite.

Estill County

The terranes of Estill County are essentially sandstones, shales and limestones of Mississippian age. However, many

tongues of the Pennsylvanian system extend westward into the Mississippian formations.

To the east of Irvine, the county seat of Estill County, there occurs a hill known as "Minerva Mountain." On the side of this mountain, or knob, the strata are more or less exposed from the Ohio shale to the Lower Carboniferous limestone. A vertical section shows in the Upper Waverlian series 24 feet of a massive, buff colored, argillaceous sandstone. This sandstone could furnish building stone for local use. The remainder of the rocks on the mountain are too shaly and friable for building stone.

Near Cottage Furnace there occurs a sub-Carboniferous limestone in beds of merchantable thickness. The stone is of gray color, fine grained and granular. Its calcium carbonate content reaches 92.02 per cent. It is siliceous and non-dolomitic. Some beds should be found in this limestone that would furnish good building stone for local use. Lithographic limestone has been quarried in this county, but the exact location is not known to the author.

Floyd County

All the terranes of Floyd County are of Pennsylvanian age. No limestones are known to occur within the county. The building stones of Floyd County are therefore all sandstones.

(1) There is an abandoned quarry 150 yards east of West Prestonsburg which was in active operation some 15 years ago. The stone is bluish gray in color, fine grained, and of even texture. Some of the individual beds are 8 to 10 feet thick. The total thickness of the working face could easily be 50 feet. The foundation of the Walter S. Harkins residence came from this quarry. The quarry is now owned by H. H. Fitzpatrick of Prestonsburg.

(2) This quarry is owned by Mrs. Josie D. Harkins of Prestonsburg. It is situated one-half mile from Prestonsburg on the east side of the Levisa River. A working face 1,000 feet in length and 50 feet in height could easily be obtained. The stone is white to a yellowish white in color, fine to medium grained,

with some surfaces long exposed somewhat iron stained. The quarry opening is now small, but stones for local use could easily be secured.

2. HARKINS LAW BUILDING.
This building is at Prestonsburg, Floyd County, Ky., and was built of Rowan County freestone.

(3) The quarry owned by L. P. May and Thomas Lanhan is situated 1 mile from Prestonburg on the east side of the Levisa River. The stone is the same as No. 2. It is used for curbing, foundation work and paving the streets of Prestonsburg, the county seat. A 30-ton crusher is at work here.

(4) The Anna Mayo quarry is situated 2 miles above Prestonsburg on the east side of the Levisa River. The stone is white to yellowish white in color, of medium texture, with perfect rift and grain. The stone is being quarried for bridge purposes and foundation work. The author has named this formation the Peach Orchard sandstone from Peach Orchard in Lawrence County, where this sandstone is especially abundant and thick bedded.

The stone hammers a pure white, and is pleasing in its effect. Along this ridge a quarry opening can be secured more than 1,000 feet in length, with a height of working face more than 50 feet. The purer and better blocks should be saved for constructional work, and the grout used in road work.

The sandstone underlying this building stone is not a commercial proposition.

(5) At Cliff, some 2 miles below Prestonsburg on the Chesapeake & Ohio Railroad, this same sandstone appears in beds from 30 to 40 feet in thickness. Some of the blocks are fairly white, while others are iron stained by the iron content of the soil overburden. No recent work has been done at this opening.

(6) Just below Banner, some 10 miles above Prestonsburg and on the west side of the Levisa, a drab colored, fine grained, even textured, massive, micaceous sandstone has been quarried for a retaining wall for a siding to a coal tipple. The stone weathers well, works easily, and some 5,000 cubic feet of the stone has been quarried.

The Bank Josephine at Prestonsburg was built in 1916 of Rowan County Freestone from the Dr. Van Antwerp quarry. The columns and trimmings are of Bedford, Indiana, oolitic limestone.

Greenup County

The terranes of Greenup County comprise both the Pennsylvanian and the Mississippian systems. The former system predominates. There was but one quarry visited in this county, and only one quarry is known to exist within the county. This is in the extreme southeastern corner of the county, at Mandy. At this quarry there is 15 feet of grayish white to white sandstone, beneath which there is 20 feet of massive, hard, bluish gray, somewhat micaceous sandstone. This stone is also fine grained, of even texture, and would make a good buliding stone for local use. Greenup is the county seat.

On the hill to the north of South Portsmouth thick beds of massive, buff colored, even textured sandstone occur. These could be used locally. The same buff colored sandstone occurs at Limeville, a few miles above South Portsmouth.

Near the Kenton Furnace the Mississippian limestones are more or less massive, of light gray color, and traversed by small veins of calcite. The calcium carbonate content reaches 94.98 per cent. The limestone is non-dolomitic, and carries a little clayey matter.

Harlan County

The terranes of Harlan County are all Pennsylvanian, save a narrow strip of Mississippian limestone traversing the northern part of the county, and brought up by the Pine Mountain fault. While at Middlesboro one large quarry in sandstone was reported to be active at Harlan, the county seat, and the stone was said to be used locally for foundations, curbing and paving. This stone was reported as a massive sandstone that would make a very good building stone with judicious selection of the building blocks.

Jackson County

The terranes of Jackson County consist mostly of the Pennsylvanian system, with outliers of the Mississippian system in the northwestern part of the county. Since this county is situated directly to the east of Rockcastle County, which is so rich in its building stone possibilities, it is only reasonable to expect that good building stone for local use may be found in the Mississippian system, and that it has been used at McKee, the county seat.

Johnson County

The terrancs of Johnson County all belong to the Pennsylvanian system. The one building stone in the county is a sandstone. The one quarry is on the farm of Bud Stafford, just outside of the city limits of Paintsville, the county seat, and south of Paint Creek. This quarry was active in 1909, for in that year the John C. C. Mayo College at Paintsville was erected, and also the Mayo Memorial Church, now known as the Southern Methodist Church. This church was the gift of Mr. Mayo. The large columns in the front of the college are sectional, and show few, if any, defects. Each of the small columns represents a single piece of stone, hand finished, and illustrates well the decorative effect of this stone. The stone was in part hauled across Paint Creek by mules, and in part sent over by tram. A large and profitable quarry can be opened up at this site. The spalls around the quarry are still bright, showing no oxidation of an iron content. This also holds true of the quarry face.

This sandstone is of neutral gray color, fine to medium grain, even texture, micaceous, sufficiently soft to work easily, sufficiently hard to cut to a sharp edge, and with good rift and grain. The aluminum content is sufficiently high to suggest that this sandstone is arkosic.

3. JOHN C. C. MAYO COLLEGE.

This college is at Paintsville, Johnson County, Ky. The large columns are sectional and came from the Mayo quarry. The small columns were made by hand from single blocks of sandstone from the same quarry.

It is not definitely known to the author that this formation has ever received a definite stratigraphical name. Therefore, the name Paintsville Sandstone is proposed, which upon petrographic study may later be changed, if sufficiently arkosic, to the Paintsville Arkose. It is at Paintsville that this formation reaches its best development as a building stone. Massive sandstones also occur in other localities near Paintsville, the county seat of Johnson County.

Knott County

The terranes of this county are entirely Pennsylvanian, and the outcrop should be chiefly sandstone. No quarry is known to exist in the county, but that does not preclude the possibility of quarrying sandstone for local use.

Knox County

The terranes of Knox County are entirely in the Pennsylvanian system. The prevailing building stone is a micaceous sandstone. This sandstone is of neutral gray color, fine to medium grain, even texture, and works easily. The 4 quarries in the county are all similar in structure and composition.

(1) This quarry is situated about one-half mile east of Barbourville, the county seat of Knox County. The quarry is said to be owned by F. D. Sampson, Judge of the Court of Appeals. The stone for the First National Bank of Barbourville came from this quarry. It is a good building stone.

(2) The Judge Tuggle quarry is situated about 1 mile northwest of Barbourville. The stone has been used quite a little locally, and is a good building stone.

(3) This quarry is situated some 3 or 4 miles to the southeast of Barbourville on Fighting Creek. It is on land owned by Mrs. Raswick. The stone is harder than at either of the quarries mentioned, and is therefore better for road work, but not necessarily better for constructional work.

(4) A quarry not visited by the author was reported to exist at Heidrick, and the stone said to be used locally for building purposes.

Laurel County

The terranes of Laurel County are Pennsylvanian in age, save the extreme western border along the Rockcastle River, which is Mississippian.

There is a large quarry in Chester limestone 1 mile south of Livingston, on the east side of the Louisville & Nashville Railroad. The individual beds are from 2 to 5 feet in thickness. The stone is of steel gray color, fine grained, dolomitic, and a fine building stone.

Lawrence County

The terranes of Lawrence County belong to the Pennsylvanian system. Therefore, the only rocks suitable for building stone in Lawrence County are sandstones. These are very abundant. As a rule these sandstones will not bear the cost of

long transportation, but as local building stones they have proved of value in the construction of dwellings, underpinnings, chimneys, fireplaces, curbing and culverts for railroads. Some of the sandstones can be cut into blocks of considerable dimension, but the most of it is better suited for the rougher purposes. It serves as a cheap and very accessible source of supply.

4. COUNTY JAIL.

This jail is at Louisa, Lawrence County, Ky. It was built of Rowan County freestone.

Most of the sandstone is micaceous, and much of it is arkosic. Most of it is from fine to medium grain in texture, but part of it is coarse and conglomeratic. A part of it is friable and disintegrates readily to a fine sand. When such exposures are windswept the surface of the exposure is often white or yellowish white in color. A part of the sandstone is of neutral gray or bluish gray color, and very massive. The neutral gray sandstone is always resistant, but the yellowish white sandstones are more friable and become resistant after the evaporation of the quarry water. Some of these were used as curbing in Louisa fifty-five years ago, and are still quite well preserved.

The Mahoning sandstone is quite well exposed along the Big Sandy River. It has been used by the Norfolk & Western Railroad along Tug Fork, and by the Chesapeake & Ohio Railroad on Levisa Fork. The Pottsville formation contains many merchantable sandstones, and some of these have been used in construction work around Louisa, and by the railroads mentioned above. These sandstones have proved valuable.

A sandstone higher than the Mahoning has been quarried for local purposes on Whites Creek, near Egypt.

There have been at least five quarries opened in Lawrence County, and possibly more.

(1) The Snyder Brothers quarry is situated three-fourths of a mile west of Louisa, the county seat of Lawrence County. The stone is massive, of dark bluish gray color, and resistant. The United States Government secured the stone for the lock and dam at Louisa from this quarry.

(2) The Saltpeter quarry is situated at Saltpeter, West Virginia, 4 miles south of Louisa, but according to Colonel Jay H. Northup, the stone for the lock and dam on Tug Fork at Saltpeter came from both sides of Tug Fork.

(3) *The Chapman Quarry.* This quarry is located at Chapman, 8 miles south of Louisa, on Levisa Fork. The stone for the lock and dam at Chapman came from this quarry.

(4) This quarry was situated within the corporate limits of Louisa. It furnished the bluish gray, massive sandstone for the foundations of the courthouse in Louisa. The whitish or yellowish white sandstone used so largely in Louisa for curbing came from the same quarry.

(5) A bluish gray sandstone is reported to have been quarried just north of Kise station along the Chesapeake & Ohio Railroad on Levisa Fork, about midway between Richardson and Chapman. The beds are from 40 to 50 feet in thickness, and massive building stone can here be secured in large quantities.

At Buchanan, 1 mile south of Louisa, on the farm of Mrs. Stump, there occur many bluffs of a yellowish white sandstone, with beds from 25 to 30 feet in thickness. According to C. J. Lawrence of Louisa, while drilling a well one-third mile south of Buchanan, 70 feet of this sandstone was encountered.

Two or more peridotite dikes were reported by J. S. Hudnall, Assistant Geologist of Kentucky, to occur on Georges Creek in the southern part of the county. The peridotite is practically identical with the Elliott County dikes.

Lee County

The terranes in the eastern part of Lee County are all members of the Pensylvanian system, while those in the western part of the county are in part Mississippian. There are three active quarries within the county.

(1) This quarry is situated at Yellow Rock on a branch of the Louisville & Nashville Railroad between Irvine, the county seat of Estill County, and Beattyville, the county seat of Lee County. The quarry is owned by Boggs and Burnham of Richmond. The quarry is quite large and produces excellent stone for local use.

(2) This quarry is situated at Willow, some 4 miles west of Beattyville. The stone is used for culverts, bridges, railroad ballast and road work. The output is about 1,000 tons per day.

(3) This quarry is on Contrary Creek a few miles southwest of Beattyville. It is a good building stone, and one of the best road building rocks of the State.

(4) *Government Quarry.* This quarry is on the opposite side of the river from the Yellow Rock quarry. The stone has been quarried by the United States Government, and used in construction work along the Kentucky River.

Leslie County

The terranes of this county belong entirely to the Pennsylvanian system. The outcrop should be prevailingly sandstones. The county was not visited, and it is not known to the author that any quarries have been opened up within the county.

Letcher County

The terranes of Letcher County all belong to the Pennsylvanian system, save a narrow strip in the southern part of the county, where the Pine Mountain fault has brought the Missis-

sippian limestone into view. The outcrops of rock over most of the county would be sandstones, which should furnish some local building stone.

There is one quarry in the county, situated between Jenkins and Pound Gap. It produces a considerable amount of stone for local consumption. The rock is mostly the cherty limestone of the St. Louis formation.

Lewis County

By consulting the geologic map of Kentucky the terranes of Lewis County will be seen as essentially Mississippian. In the southeastern portion the Pennsylvanian system is represented. In the northern and western portions the Devonian, Silurian and Ordovician formations occur.

The county seat of Lewis County is Vanceburg. It is situated on the Ohio River. In the eastern end of the town there is a hill known as Alum Rock. W. C. Morse, in his report on the Waverlian formations of East Central Kentucky, gives a section exposed here with the following thickness:

	Feet
Cuyahoga formation	39
Sunbury shale	15 1/2
Berea grit	22 1/4
Bedford formation	95 5/6
Ohio shale	242

In the Berea there is 15 feet of medium to coarse grained gray sandstone, and in the middle of the Bedford formation there is 38 1/3 feet of sandstone varying from thin bedded gray sandstones at the top to thick bedded buff sandstones toward the bottom of the series. The sandstones occur in definite even layers, which either alternate with shales, or have shaly partings. These sandstones would make good building stone.

Vanceburg Hill is about 3 miles from Vanceburg. On the south side of the hill the rocks are well exposed. Morse gives for this section:

	Feet
Cuyahoga formation	182 2/3
Sunbury shale	15
Berea formation	19 1/2

In the Cuyahoga formation there is 75 feet of excellent building stone. These are mostly thick bedded, argillaceous sandstones, ranging in color from buff to blue.

In several other sections of the county fine grained, buff to blue sandstones can be secured for building purposes. The limestones of Lewis County are also in many instances suitable for constructional purposes.

Sixteen quarries were located in Lewis County. A part are in the limestones and a part in the sandstones.

(1) *City Quarry.* This quarry is located within the city limits, and is one of the best in the county. It furnishes much of the stone for underpinnings, curbing and street work. The rock is limestone.

(2) *Clarksburg Quarry.* This quarry is situated 3 miles southwest of Vanceburg. It appeared inactive. The product is limestone.

(3) *L. Love Quarry.* This quarry is located 3½ miles west of Vanceburg at the mouth of Quicks Run. This represents an excellent constructional stone. The stone used for the lock and dam at Vanceburg came from this quarry.

(4) *Tolesboro Quarry.* This quarry is situated 1½ miles west of Tolesboro. The quarry has furnished much excellent limestone for bridges, culverts and road work. The stone wears well.

(5) *Concord Quarry.* This quarry is located 2 miles south of Concord. It is in limestone and has furnished much limestone for local use.

(6) *Carrs Quarry.* This quarry is 5 miles south of Concord. It is on the border between the limestone and the sandstone. Its vertical face varies from 8 to 15 feet.

(7) *Herron Hill Quarry.* This quarry is 10 miles southwest of Vanceburg. It is also on the dividing line between the limestones and the sandstones.

(8) *Kinney Hill Quarry.* This quarry is situated some 4 miles southwest of Vanceburg on the Kinniconick Railroad. It is in sandstone that works so easily that it has received the name freestone. The individual beds vary from 1 to 2 feet in thickness. This stone has been used extensively.

(9) *Slate Branch Quarry.* This quarry is about 1 mile east of Vanceburg. It furnished much of the stone for building purposes, curbing, sidewalks, etc., in Vanceburg. It is in sandstone.

(10) *Dry Run Quarry.* This quarry is located 1¼ miles south of Vanceburg. The stone is identical with that in quarry No. 9, and is used for the same purposes.

(11) *Town Branch Quarry.* This quarry is located 2 miles east of Vanceburg. It has furnished much stone for underpinnings for churches and dwellings. It also furnished the stone for the Union Soldiers Mounment at Vanceburg, which was the first one erected south of the Mason and Dixon line. The monument also carries the Honor Roll for Lewis County for the World War.

(12) *Grassy Creek Quarry.* This quarry is situated 4 miles south of Vanceburg. It furnished the stone for the stone front of the Max Block erected seventeen years ago. The individual beds of sandstone range from 20 to 26 inches in thickness.

(13) *Quincy Quarry.* This quarry is located 12 miles east of Vanceburg. It furnished the stone for the Christian Church in Vanceburg. The quarry is in sandstone. The stone was said to have been brought down the Ohio River in barges.

(14) *Valley Quarry.* This quarry is situated in Valley, Kentucky, 7 miles south of Vanceburg. It is in sandstone.

(15) *Alum Hill Quarry.* This quarry is located on Alum Hill, only one-fourth of a mile from the courthouse. The county jail was constructed with stone from this quarry. It is in sandstone.

(16) There is a limestone quarry at Garrison on the Kinniconick Branch of the Chesapeake & Ohio Railroad which was opened in 1881, and it has been in continuous operation since that date.

Magoffin County

The terranes of Magoffin County all belong to the Pennsylvanian system. Therefore, the prominent outcrops are essentially sandstones. Four different horizons of sandstone beds are shown around Salyersville, the county seat of Magoffin County.

These sandstones should furnish fairly satisfactory building stone for local use. Distance from railroads prohibits the transportation of building stone for long distances.

Martin County

The terranes of Martin County are all in the Pennsylvanian system. The outcrops are essentially sandstones. Some of these would make good building stone, and also furnish good stone for the railroads immediately to the east of Tug Fork.

McCreary County

The terranes of the eastern part of McCreary County fall in the Pennsylvanian system and are therefore sandstones in most of the outcrops. Those in the extreme northern portions of the county, and many sections of the western part of the county, are in the Mississippian formations.

These sandstones and limestones have furnished local building stone and much stone for the Quincy & Cynthiana Railroad, which traverses the center of the county in a north and south direction through Whitley, which is the county seat of McCreary County.

Menefee County

The terranes of the eastern part of Menefee County belong to the Pennsylvanian system. This group of sandstones sends many tongues of the Pennsylvanian rocks out into the Mississippian formations. There are also several outliers of Pennsylvanian rocks among the Knobs.

There are three belts of Lower Carboniferous rocks in the county.

(1) This exposure is along the western border of the county.

(2) This one lies along the Licking drainage to the north.

(3) This exposure falls along the Red River drainage on the south.

Frenchburg, the county seat of Menefee County, is reached by a spur of the railroad from Mt. Sterling. Along the highway between Frenchburg and Rothwell there is exposed 72 feet of Lower Carboniferous limestone underlaid by the Waverlian

series. This limestone has been used extensively for local building purposes, culverts, bridges and railroad work. The Mississippian series has very materially narrowed in passing southward from Lewis County to Menefee County.

Morgan County

The terranes of Morgan County all fall in the Pennsylvanian system, save a somewhat limited area in the northwestern part of the county, which is Mississippian.

The conglomeratic sandstones attain a maximum thickness of approximately 200 feet. These are well shown near the mouth of Greasy Creek, west of the town of Licking River. The outcrops are more or less massive, and should furnish good building material.

The sub-carboniferous limestone which rests upon the Waverlian formations, without any considerable thickness of transition rocks, has an average thickness of about 50 feet. In the Licking Valley in the northwestern part of the county the Waverlian formations attain a thickness of approximately 200 feet. These are essentially sandstones and shales. The limestones contain both the dark gray and the light gray oolitic types. They are non-dolomitic, practically free from iron, the combined ferrous and feric oxide reaching only 0.32 per cent. The calcium carbonate content reaches 91.60 per cent, clayey matter practically absent, and the silica content reaches 5.90 per cent. These rocks are therefore siliceous, oolitic limestones, that would make a most excellent building stone.

Another type of the limestone in Morgan County is light gray and crystalline, with an irregular fracture. Its calcium carbonate content reaches 97.40 per cent. It is non-dolomitic, free from iron and susceptible of a good polish. It is suited not only for construction work, but also for decorative interior work. West Liberty is the county seat of Morgan County.

Owsley County

The terranes of Owsley County all belong to the Pennsylvanian system, and the outcrops would therefore be essentially sandstones. No railroad penetrates the county. The county seat is Booneville. The county was not visited by the author.

Perry County

The terranes of Perry County are entirely confined to the Pennsylvanian system. Particularly hard, massive and durable sandstones are known to exist in this county, and to have been used locally. A good exposure of these hard sandstones can be seen near the mouth of Leatherwood Creek. Hazard is the county seat of Perry County.

Pike County

The terranes of Pike County are all situated in the Pennsylvanian system, save a narrow strip in the extreme southwestern part of the county, where the Pine Mountain fault has brought the Mississippian limestone into view. This narrow belt of St. Louis limestone terminates at Elkhorn City. The commercial stones, therefore, of Pike County are sandstones. Six quarries are known within the county. All save one are within or close to Pikeville, the county seat.

5. QUARRY SITE.

This quarry site is in fine grained, bluish gray, micaceous sandstone, Pikeville, Pike County, Ky.

(1) *Thomas Hoffman Quarry.* This quarry is situated on the east side of Levisa Fork, within the city limits. A quarry

face of 1,000 feet could easily be opened. The beds range from 1 to 18 feet in thickness. The stone has been used for dwellings, underpinning, bridges, culverts, curbing, and paving. The rock is a faintly bluish gray, fine grained, micaceous, and slightly arkosic sandstone. It has perfect rift and grain, hammers white, and works easily. It weathers well and is an excellent building stone. For a more detailed description of the character of this building stone see the description of Slide No. 14 in Chapter IV. An analysis of this stone will also be found in Chapter XI, under Pike County.

6. QUARRY PROSPECT.
This quarry prospect is in fine grained, bluish gray, micaceous sandstone, Pikeville, Pike County, Ky.

(2) The Oscar Love quarry is also located on the east side of Levisa Fork. It is understood to be a part of the same bluff with the same characteristics of the stone as have been cited for No. 1.

(3) This quarry is some 4 miles east of Pikeville on the county road to Williamson, West Virginia. In the construction of this road during the past two years much stone has been

obtained here for bridges, culverts, and general road work. The stone is very massive, thick bedded, micaceous, arkosic, of bluish gray color, and well suited for both constructional and road work.

7. RETAINING WALL.
This retaining wall was built of fine grained, micaceous sandstone from Pikeville, Pike County, Ky.

(4) *T. J. Williamson Quarry.* This quarry is situated at the south end of the main paved street, close to the city line, in what is known as Happy Hollow. It is also known as the Happy Hollow Quarry. The stone is of neutral gray color, fine grained, micaceous, and works easily. This quarry has furnished the stone for much foundation work, retaining walls, etc. It is an excellent building stone, for some of these walls show no evidence of the oxidation of an iron content.

(5) This quarry is situated 1 mile north of Pikeville and about 25 rods west of the Chesapeake & Ohio Railroad. The stone is of neutral gray color, fine grained, micaceous, and has been used largely in underpinning for houses, for curbing and paving the streets of the northern part of Pikeville.

(6) This quarry is situated from 1½ to 2 miles north of Pikeville along the Chesapeake & Ohio Railroad, where stone was reported to have been quarried for the construction of the railroad. The stone is of bluish gray color, fine to medium grained, massive, compact, with good rift and grain. The quarry is inactive.

Powell County

The terranes of Powell County are quite widely varied in age. A small belt of Pennsylvanian rocks stretches along the northern, eastern and southern border of the county. The central portion is occupied almost entirely by the Mississippian system, which sends tongues far out into the Pennsylvanian strata. The western portion of the county carries strata of Silurian and Devonian age.

8. STONE RESIDENCE.

This residence was built of local sandstone. Pikeville, Pike County, Ky.

Stanton, the county seat, is situated near the center of the county on the Lexington & Eastern Railroad. The Cuyahoga formations and the Sunbury shales around Stanton are too thin bedded and too friable for building purposes.

Morris Mountain is situated about 2 miles north of Stanton. On the sides of this mountain there occurs 63 feet of massive, argillaceous, buff colored sandstones, with some shaly layers

in the lower portion, which should make a fairly satisfactory building stone for local use only. Lower Carboniferous limestones outcrop toward the top of the mountain. The upper portion of the limestone is of light gray color and apparently commercial, while the lower portion turns yellow upon exposure to the atmosphere, suggestive of an undesirable iron and magnesium content.

There is a quarry on the Louisville & Nashville Railroad about 5 miles from Glencairn, Wolfe County. This quarry is one of the largest in Eastern Kentucky. The length of the quarry is 200 feet, or more. The breadth 200 feet, and the height of the working face is approximately 100 feet. The bottom of the quarry is the Ste. Genevieve limestone. The oolitic beds are overlaid by the St. Louis massive, yellowish gray limestone, which in turn is overlaid by all of the Chester series. Thin coal seams are seen in the top of the quarry. The quarry contains excellent building stone.

Pulaski County

The terranes of Pulaski County are essentially Mississippian. They are so pronouncedly Mississippian that the county might well have been described in another chapter. The Mississippian formations send long tongues far out into the Pennsylvanian system, which occupies a narrow belt in the eastern part of the county. There are also several outliers of Pennsylvanian strata to the east and southeast of Somerset, the county seat of Pulaski County. Here erosion has failed to remove all of the Pennsylvanian terranes. To the west of Somerset there is an outlier of Devonian and Silurian formations completely surrounded by the Mississippian terranes.

The quarries are more numerous in this county than in any other county in eastern Kentucky, although none of them even approximate in size to the quarry of J. W. Sparks in Rockcastle County. Twenty-two quarries have been listed; most of them are small, and some are inactive. They are all in the limestone series.

(1) *Thomas Meece Quarry.* This quarry is situated on the southwest side of Reservoir Knob, just outside the city limits. The quarry is of average dimensions, but a quarry with

a working face several hundred feet in length, and more than 50 feet in height of face, could easily be opened. The present quarry is 150 feet in length, 50 feet in breadth, and with a working face of 30 feet. There is a rock crusher at this quarry, and the stone is all used for pike purposes, although the thicker beds are an excellent building stone.

The rock in the upper half of the quarry is mineralogically and commercially a marble, for it is completely recrystallized with the calcite showing perfect rhombohedral cleavage. It is also susceptible of a good polish, and well suited for decorative interior work. It is traversed by numerous zigzag lines of dark grayish black color, which stand out in striking contrast with the remainder of the polished surface. The marble itself is of very light brown to medium gray color, with tints of pink. Perhaps it is the commingling of the pink and the gray tints

9. LIMESTONE QUARRY.
This quarry is on Reservoir Knob, Somerset, Pulaski County, Ky. It shows the thickness of the individual beds.

that produces the light brown color effect. This marble bears a striking resemblance to the pink marble of Meadow, Tennessee, which is so extensively used for decorative interior work. A hand polished sample of this Somerset marble can be seen in the museum of the Kentucky Geological Survey in Frankfort.

There occurs also in this quarry a white to grayish white, microcrystalline limestone. The beds are massive, fine grained, and hand samples break out with a conchoidal fracture. This bed would also make a good building stone.

(2) *The Cundiff Quarry.* This quarry is owned by Mrs. Cundiff, and is situated on the north side of Reservoir Knob. The beds are massive and of bluish gray color. This quarry is inactive, although it has furnished considerable stone for constructional work, especially for the Southern Railroad System.

(3) This quarry is situated on the Stanford Pike, some 2 miles out from Somerset. The stone is of buff color. It is being used in the construction of the New Community Church on Main Street.

(4) Some 5 or 6 miles east of Somerset on the Grundy Pike there are several small quarries, all of which are listed as No. 4. The beds are massive and the stone is of medium gray color.

(5) *Jacob Mayfield Quarry.* This quarry is situated 3 miles beyond Shopville and on Short Creek. The stone is massive and of medium gray color.

(6) *Ed Thurmen Quarry.* This quarry is located 1½ miles west of Somerset. The beds are massive. The limestone is white to grayish white in color, and is identical with the white limestone of Reservoir Knob.

(7) *Norwood Quarry.* This quarry is at Norwood, some 4 miles north of Somerset. It is owned by the Dunigan heirs. This quarry has a length of 300 feet, a breadth of 200 feet, and a working face of 80 feet. It is an excellent quarry. The stone is a dark gray, crystalline marble, closely resembling the Danville marble.

(8) *J. S. Kendrick Quarry.* This quarry is situated 2 miles east of Somerset, and has been in operation intermittently for over 50 years. Two distinct types of building stone occur here. One is of medium gray color, and the other is grayish white. This quarry furnished the stone for the First Methodist Church South in 1917. The church is on the corner of Mt. Vernon Street and Central Avenue.

(9) *B. G. Vaught Quarry.* This quarry is about 1 mile east of Somerset. It has furnished much stone for foundation and veneering in Somerset.

(10) *J. H. Gibson Quarry.* This quarry is situated ½ mile southeast of Somerset, and the stone has been used for foundation work in general.

(11) *Taylor-Hudson Quarry.* This quarry is about 1 mile east of Somerset. The stone is used for foundation work. This quarry requires no stripping.

(12) *Scott Quarry.* This quarry is situated ½ mile northeast of Somerset. The stone is of brownish gray color, and is a little coarser grained than the marble of Somerset Knob. It is used for monumental work and trimmings for brick buildings.

(13) *Beecher Smith Quarry.* This quarry is located some 2 miles due east of Somerset. The stone is white or grayish white in color and has been used for building purposes, and also burned into white lime for both constructional and agricultural use.

(14) *Charles Evans Quarry.* This quarry is located on Holtzclaw Knob, 5 miles north of Somerset. It is a dark gray crystalline marble like that in the Norwood quarry.

(15) *J. M. Richardson Quarry.* This quarry is just west of Somerset. The beds are about 4 feet in thickness. The stone is of very dark gray color and crystalline.

(16) *William Denham Quarry.* This quarry is situated on the southwest side of Somerset. It is a good building stone.

(17) *Hannah Denham Quarry.* This quarry is located 2½ miles due west of Somerset, and the stone is used for building purposes.

(18) *The Burton Quarry.* This quarry is about 8 miles west of Somerset. The stone was used in the walls around the cemetery and for monumental work.

(19) *William Lee Quarry.* This quarry is about 8½ miles west of Somerset. The stone is used for the same purposes as that in the Burton quarry.

(20) *Samuel Higgins Quarry.* This quarry is some 2 miles southeast of Somerset. It is a fine grained, bluish gray limestone used for building purposes.

(21) *Fletcher Gover Quarry.* This quarry is located at Cedar Grove some 4½ miles south of Somerset. It has been in operation for many years.

(22) *Lincoln Denton Quarry.* This quarry was within the city limits. The stone was used in many buildings on Main Street, and in the retaining walls on the west side of Main Street.

The weathering qualities of the Somerset limestones and marbles are well evidenced by the outside stone chimneys built from 1835 to 1850. The retaining wall in front of the home of B. Z. Ingram, 304 South Main Street, Somerset, came from the foundations of a dwelling and an outside stone chimney reported to have been erected more than 100 years ago. Many of these blocks show no ill effects from long continued weathering.

Rockcastle County

The terranes of Rockcastle County are essentially Mississippian, but the Pennsylvanian system is represented in a rather narrow belt in the eastern part of the county. The Mississippian system has sent many narrow tongues far out into the Pennsylvanian strata. There are also many outliers of the Pennsylvanian rocks in the Mississippian area. In the extreme northwestern part of the county there is a small area of Devonian and Silurian outcrops.

Limestones, marbles and sandstones are well represented. The commercial marbles receive a good polish, and are capable of wide industrial application. The sandstones are fine grained, even textured, and their reputation could be made national.

(1) *W. J. Sparks Company Quarry.* This quarry is situated ¾ of a mile northwest of Mt. Vernon, the county seat of Rockcastle County. The quarry was opened in 1908. Four acres of stone have been removed. The present dimensions of the quarry are 1,000 feet in length, 300 feet in breadth, and 110 feet in height of working face. As the quarry is carried back further into the hill it will have a working depth of 150 feet. The product is all limestone and is used by the railroads. A large crusher prepares the stone for shipment.

Two distinct types of calcareous rocks exist in this quarry. One is a white crystalline oolitic limestone, limestone because

not completely calcitized, and the other is a massive, compact, medium gray, microcrystalline limestone. In the former, many of the oolites are still visible, and the crystals of calcite makes up the rest of the rock. It is fine grained, even textured, with perfect rift and grain, and susceptible of a very good polish. It is well suited for both constructional work and decorative

10. W. J. SPARKS COMPANY QUARRY.

This quarry is at Mt. Vernon, Rockcastle County, Ky. It shows the thickness of the individual beds. The height of the quarry face is 112 feet.

interior work. When inlaid with some of the darker marbles of Kentucky, the results would be very pleasing. A polished sample of this stone can be seen in the museum of the Kentucky Geological Survey at Frankfort. The hard, massive, compact phase breaks with a conchoidal fracture, and is best suited for bridges, culverts, retaining walls, curbing, street and railroad work. The mixed product from the quarry runs from 96 to 98 per cent calcium carbonate.

(2) *Sparks Quarry Plant.* This quarry is situated at Sparks, 3 miles south of Mt. Vernon. The stone possesses the same characteristics as given for No. 1. The quarry is 500 feet in length, 300 feet in breadth, and 142 feet in depth. The crusher has a capacity of 1,000 tons per day.

(3) *Fred Kreuger Quarry.* This quarry is within the city limits. It is in the white, oolitic, crystalline limestone

which at this quarry runs about 99 per cent calcium carbonate. While the white blocks would make an excellent building stone, yet the entire product is put into lime for agricultural purposes.

(4) This quarry is situated 4 miles southeast of Mt. Vernon on the Queen & Crescent route of the Southern Railway System. The quarry is in limestone.

(5) *Mullins Quarry.* This quarry is situated at Mullins, 8 miles due east of Mt. Vernon, and ¾ of a mile north of Sinks Junction on the Kentucky Division and Lebanon Branch of the Louisville & Nashville Railroad. The quarry is entirely in limestones possessing the same characteristics as the W. J. Sparks Company quarry. This quarry was opened in 1897.

(6) *Rockcastle Lime and Cement Plant.* This quarry and $200,000 plant is situated at Pine Hill, 5½ miles southwest of Mt. Vernon. The limestones are gray in color, fine grained, some of them crystalline, and could be used for building purposes. The bottom portion of the limestone carries 94.28 per cent calcium carbonate and 2.00 per cent silica. The central portion carries 93.21 per cent calcium carbonate and 2.85 per cent silica. The upper portion carries 93.48 per cent calcium carbonate and 2.40 per cent silica. The rock is therefore a siliceous limestone.

(7) *Local Quarries.* There are several of these around Mt. Vernon in the limestone series which are quarried intermittently to obtain stone for retaining walls, foundations and curbing.

(8) *Langford Quarry.* This quarry is situated 4 miles north of Mt. Vernon at Langford, on the Kentucky Division of the Louisville & Nashville Railroad. The quarry is owned by the Kentucky Freestone Company of Rowan County, and is known quite widely throughout the State as the Rockcastle freestone quarry. The quarry was opened in 1896. The rock is an argillaceous sandstone, of drab color, fine grain, even texture. The stone splits freely in all directions. The individual beds vary from 3 to 5 feet in thickness. The stone is remarkably free from iron, and weathers uniformly. The beauty of this stone for constructional work is illustrated by the United States Postoffice Building at Madison. The base of the Rockcastle Hotel at Mt. Vernon came from this quarry. Several instances

were found scattered over the State where this stone was used in constructional work. It is well worthy of an interstate reputation as a building stone. For a complete description of its characteristics see Slide No. 15 in Chapter V.

(9) *Wildie Quarry.* This quarry is located at Wildie on the Louisville & Nashville Railroad. The product is known as the Rockcastle freestone, with the same general characteristics as the stone in the Langford quarry.

(10) There is a small quarry near Brush Creek reported to be in the freestone, and not visited.

(11) There is a quarry about 1 mile north of Limestone on the west side of the Louisville & Nashville Railroad. This sandstone is reported to be very brittle.

Rowan County

The terranes of Rowan County are predominantly Mississippian. There is, however, a narrow belt of Pennsylvanian strata in the eastern part of the county, and the Devonian rocks, Chattanooga shale, outcrop in the southwestern part of the county on both the north and south sides of the Ashland-Louisville Branch of the Chesapeake & Ohio Railroad. The quarries, however, are all in the Buena Vista member of the Cuyahoga formation.

There are three well-known quarries in the Buena Vista. One at Farmers, one at Freestone, and one at Bluestone. These stations are a few miles to the southwest of Morehead, the county seat.

The building stones of Rowan County are argillaceous sandstones of gray or bluish gray color. They are very fine grained, and even textured. They split freely in all directions, hence the name Rowan County freestone. The lift is parallel with the quarry floor, the rift is north and south, and the grain is east and west. The beds pitch at a low angle to the east just enough for drainage. The stone cuts to a sharp edge and hammers a grayish white.

If a little care is exercised in the selection of building blocks, the stone weathers uniformly. Without this care in selection,

11. PRESBYTERIAN CHURCH, WINCHESTER, KY.

The lower half of this church was built of Rowan County freestone. The ashlar blocks in the upper half are Rockcastle County freestone. Photo by A. J. Earp.

some blocks will show discoloration by the oxidation of an iron content. The cement binding the sand grains together is clayey matter.

(1) *Rowan County Freestone Company.* This quarry is owned by Dr. Howard Van Antwerp. The quarry is situated at Farmer. The quarry is some 400 feet in length, 100 feet in breadth, and 35 feet in height of working face. The beds lie in a horizontal position, separated from each other by thin layers of blue shale, which is very soft. This fact aids materially in quarrying the sandstone. The overburden of soil and some waste rock are thrown against the quarry front, so that the quarry is not in full view from Farmer Station.

12. DR. HOWARD VAN ANTWERP QUARRY.

This quarry is at Farmer, Rowan County, Ky. It shows the thickness and horizontality of the individual beds of freestone.

The thickness of the individual beds, reading downward, is aproximately as follows:

No. 1, 12 inches, building stone.
No. 2, 12 inches, building stone.
No. 3, 18 inches, road building work.
No. 4, 18 inches, building stone.
No. 5, 14 inches, building stone.
No. 6, 30 inches, building stone.
No. 7, 21 inches, building stone.
No. 8, 27 inches, building stone.
No. 9, 12 inches, building stone.

The last layer is very hard, and has never been removed. It is used as the quarry floor to a very good advantage. Beds Nos. 6, 7 and 8 are the best for building purposes. The quarried blocks are shipped by tram to a siding at the foot of the bluff. The mill for sawing the blocks of building stone, dimension size, was burned May 14, 1921, and a new mill has just been constructed at the old site.

13. DR. HOWARD VAN ANTWERP QUARRY.

This quarry is at Farmer, Rowan County, Ky. It shows the thickness and horizontality of the individual beds; also the thickness of the intercallated shale beds.

In breaking the stone into suitable blocks for road foundations a pear-shaped, cast iron ball weighing 2,200 pounds drops from 5 to 15 feet, according to the thickness of the block to be broken. In the construction of a permanent road in Farmer a 10-inch bed of this broken stone was used, covered by 4 inches of crushed limestone, and top-dressed with 2 inches of Kentucky rock asphalt. The total output of this quarry could easily reach 1,000,000 cu. ft. of stone per annum. The same Buena Vista sandstone stretches southward into the hills for some three or four miles, and in places the individual beds are reported to be 40 inches in thickness.

The Rowan County Freestone Company furnished the stone for the railroad station at Farmer in 1910. This stone was also used for the abutments and central pier of the Chesapeake & Ohio Railroad bridge over the Licking River.

(2) *Bluegrass Quarries Company.* This quarry is owned and operated by C. S. Brown of Huntington, West Virginia. The quarries are situated some ¾ of a mile southwest of Rockville Station. The shipping point is Freestone and the postoffice is Bluestone. The quarry is perhaps a little smaller than that of the Rowan County Freestone Company, but the overburden is not quite so heavy. At the quarry there are 13 beds of bluish gray, fine grained sandstone, with approximately the following thickness, reading downward:

No. 1, 5 inches, road stone.
No. 2, 12 inches, building stone.
No. 3, 11 inches, building stone.
No. 4, 15 inches, building stone, buff colored.
No. 5, 6 inches, building stone, steel gray.
No. 6, 10 inches, building stone.
No. 7, 18 inches, building stone, best grade of quarry.
No. 8, 18 inches, building stone.
No. 9, 8 inches, road stone.
No. 10, 30 inches, building stone.
No. 11, 22 inches, building stone.
No. 12, 32 inches, building stone.
No. 13, 14 inches, building stone, not quarried.

This bottom layer is used as the quarry floor. All the beds make excellent building stone, save Nos. 1 and 9. These, on account of an iron content, are better suited for road construction than for building purposes.

The Bluegrass Quarries Company has a mill at the foot of the bluff, equipped with gangs of saws for cutting the stone into dimension sizes before shipment for constructional work. The stone is brought to the mill by gravity roads. The evenness of the layers and the various layers of different thickness give a product of most any desired thickness with the least possible expense. The thin, soft, shaly layers between the different sandstone beds facilitate the quarrying of the stone.

14. MILL OF THE BLUEGRASS QUARRIES COMPANY.
This mill is at Freestone, Rowan County, Ky. It shows the method of handling large blocks of stone.

(3) *Kentucky Bluestone Company, Inc.* This quarry is located at Bluestone, on the Ashland-Louisville branch of the Chesapeake & Ohio Railroad. The quarry is in the same bluish gray to gray, fine grained, argillaceous sandstone of the Buena Vista formation. The beds here also are separated by thin layers of soft shale, which facilitates the quarrying. The stone is split with shims and wedges so that there is no waste of material from fracture by explosives. The stone is shipped to the mill by a gravity road. The quarry is about ¼ of a mile west of the mill. The thickness of the individual beds of sandstone, reading from the top downward, are aproximately as follows:

No. 1, 10 inches, building stone.
No. 2, 12 inches, building stone.
No. 3, 9 inches, road stone.
No. 4, 15 inches, building stone.
No. 5, 9 inches, road stone.
No. 6, 19 inches, building stone.
No. 7, 17 inches, building stone.
No. 8, 21 inches, road stone.
No. 9, 12 inches, is used as the quarry floor.

Beneath this layer there are 2 other layers from 12 to 15 inches in thickness that are kept as a quarry reserve. Beneath this sandstone is the black Chattanooga shale of Devonian age.

15. QUARRY OF THE KENTUCKY BLUESTONE COMPANY.

This quarry is at Bluestone, Rowan County, Ky.

The quarry as opened is about 600 feet in length, with a breadth of 200 feet, and vertical depth of some 30 feet. At least 5 acres of stone appear to have been removed. The quarry is fully capable of putting out more than 100,000 cu. ft. of stone per annum.

The company has a good mill with modern machinery for cutting the stone with gang saws, into dimension blocks, and dressing the stone as may be desired. The steel saws are fed with silica sand and water to aid in the cutting. About one-half of the quarry output is sawed on 2 sides, and one-half is sawed on 4 sides.

The product from this quarry has been used extensively for building purposes, and with a judicious selection of the

blocks, the stone weathers uniformly. Under the name of block stone the Kentucky Bluestone Company produces mill blocks, bridge stone, and monument bases. Under sawed stone, sawed curbing 4 by 18, 5 by 18, and 6 by 18 inches; sawed stone, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 inches thick; sawed flagging, 2, 2½, 3, 3½ and 4 inches in thickness; also sills, steps, and columns.

16. QUARRIED BLOCKS OF BLUESTONE.
These blocks are at the mill of the Kentucky Bluestone Company, Bluestone, Rowan County, Ky.

(4) There is an opening in the same Buena Vista formation 7 miles north of Bluestone, where the beds attain a maximum thickness of 7 feet. This locality may be regarded as a sandstone reserve.

Wayne County

The majority of the terranes of Wayne County fall in the Mississippian system. There is, however, quite an extensive

area of Pennsylvanian strata in the southwestern part of the county, and a much smaller area of Devonian shale in the northwestern part of the county. The quarries are all small, and located in the Mississippian formation.

(1) *Dr. William Cook Quarry.* This quarry is situated just outside the city limits of Monticello, the county seat of Wayne County, and a little to the southwest. It is furthermore just across the first small stream after leaving Monticello. This quarry furnished the stone for the First Baptist Church at the corner of Main and St. Paul Streets. The church was erected in 1918 and illustrates very well the architectural effect of the building stone of Wayne County. The stone is of medium to dark gray color, and fine grained.

17. NEW BAPTIST CHURCH.

This church is at Monticello, Wayne County, Ky. It was built in 1918 of limestone quarried within the city limits.

(2) *County Jail Quarry.* This quarry is on the same creek as No. 1, and not far from the Cook quarry. It furnished the stone for the county jail, which was erected in 1898. This building shows well the weathering qualities of the stone, for it has been exposed to the corrosive agents of the atmosphere for nearly a quarter of a century.

(3) This quarry was reported to be a short distance south of Monticello, and the stone used for bridging and curbing.

(4) This quarry is said to be near No. 3, and the stone used for the same purposes. The quarries are in limestone and very small.

(5) At Mill Springs in Wayne County a limestone quarry furnished the stone to build the canal along the cliff.

It is interesting to note that directly across the street from the Baptist Church at Monticello, where excavations were being made for a cellar, the excavations were in a pink cherty marble with numerous black zigzag bands traversing the stone. It was filled with crinoidal stems, which are now chert with calcite pitts.

Whitley County

The terranes of Whitley County all belong to the Pennsylvanian series, save for a narrow strip in the southwestern part of the county, which is traversed by the Pine Mountain fault. Here the St. Louis limestone of Mississippian age has been brought into view.

The prevailing rock exposures are Pennsylvanian conglomerates and sandstones which are often massive enough and sufficiently thick bedded for local building purposes. On Cumberland River at Cumberland Falls the Pottsville is well exposed, and some 50 feet in thickness.

There is a quarry on a branch of the Louisville & Nashville Railroad, 1 mile west of Williamsburg, the county seat of Whitley County. The rock is a sandstone of reddish brown color. The working face is from 30 to 40 feet in height.

Wolfe County

The terranes of Wolfe County all belong to the Pennsylvanian system, save a few small areas in the northwestern part of the county. Here long tongues of the Mississippian strata have been sent far out into the Pennsylvanian system. Campton is the county seat of Wolfe County. While it is not known to the author that there are any active quarries within the county, it is possible that some has been quarried and used locally around Campton.

Number of County.	Name of County.	Number of Quarries in County.
1	Bell	10
2	Boyd	9
3	Breathitt	1
4	Carter	11
5	Clay	0
6	Clinton	5
7	Elliott	0
8	Estill	1
9	Floyd	6
10	Greenup	1
11	Harlan	1
12	Jackson	0
13	Johnson	1
14	Knott	0
15	Knox	4
16	Laurel	1
17	Lawrence	5
18	Lee	2
19	Leslie	0
20	Letcher	1
21	Lewis	15
22	Magoffin	0
23	Martin	0
24	McCreary	1
25	Menefee	1
26	Morgan	0
27	Owsley	0
28	Perry	0
29	Pike	6
30	Powell	1
31	Pulaski	22
32	Rockcastle	12
33	Rowan	4
34	Wayne	5
35	Whitley	2
36	Wolfe	0
Total number of quarries		128

CHAPTER VII

CENTRAL KENTUCKY OR THE BLUEGRASS SECTION

The Bluegrass section of north central Kentucky embraces more counties than any other distinct geographic Province of the State. This chapter not only includes the counties affected by the Cincinnati Arch in its southern extension into Kentucky, but also the Knob counties adjacent on the south and southwest. The Knob counties on the east were included in Chapter VI.

The terranes described in this chapter are predominately Ordovician, with the Cincinnati series far in excess of the Champlainian. The Silurian, Devonian and Mississippian series are represented in the Knob counties.

Anderson County

The terranes of Anderson County are all Ordovician. Both the Cincinnatian and the Champlainian series are represented. The Eden Stage of the Cincinnatian covers the western part of the county, but the eastern part of the county is traversed by beds of Champlainian rocks of great commercial value. The Eden shales are too thin bedded and friable for building stone. The Tyrone fromation, however, is one of the best building stones in America. It is Champlainian.

(1) *Tyrone Quarry.* The village of Tyrone and the quarry are both on the west side of the Kentucky River, a few miles east of Lawrenceburg, the county seat of Anderson County. The quarry is owned and operated by the Ripy Brothers. The quarry is approximately 300 feet in length, 250 feet in breadth, and 125 feet in depth. The heaviest individual bed is about 10 feet in thickness.

The Tyrone limestone is a very massive, compact, thick bedded, white to dove colored building stone. It breaks with a conchoidal fracture, and trims easily into ashlar blocks. Sawed faces are especially pleasing. The stone shows on its fractured surfaces facets of calcite, which have given to the rock the name "birdseye limestone." The perfect cleavage of these rhombs of calcite sparkle by reflected light like the eyes of a bird. According to Prof. A. M. Miller these facets are the calcite

fillings of minute tubes penetrating the rock. The tubes were probably the molds of seaweed stems. If so, then this limestone was algal. For the detailed petrographic study of a microscope slide of this rock see Slide No. 9 in Chapter V.

The author has constantly found the name "Kentucky marble" applied to the Tyrone formation. It is not entirely a misnomer, for under the miscroscope this building stone is proven to be a semi-crystalline limestone or marble. It is free from both silica and iron oxide. The stone weathers white, and presents a very pleasing effect wherever used. For a chemical analysis of a sample of olive gray limestone from the middle of the Tyrone formation, see No. 1, Chapter XI. The sample from which the analysis was made was dolomitic and siliceous, and therefore could not have come from the same layer as the one from which the microscopic slide was cut, for that is non-dolomitic and non-siliceous.

Kentucky Marble has been used quite extensively for building purposes. It can be seen in many of the more substantial buildings and finer residences in Frankfort, such as the Old State House, the Old Penitentiary walls, now the State Reformatory, a number of attractive homes in South Frankfort, and in a large number of retaining walls. The Kentucky River Marble, which was used in the construction of the walls of the Old State House, was quarried along the Kentucky River above the City of Frankfort under the direction of a Mr. Evans. It was barged down the river and hauled to the State Penitentiary, where it was sawed and polished by convict labor* under the direction of the Keeper, a Mr. Scott. The work was started in 1827, and when completed in 1828 its bright, white surface and classic lines caused it to be aptly described as one of the most beautiful buildings in America. Kentucky River Marble was used in the Old Capital Hotel, and the white walls stood erect after the fire, until torn down to give way to the construction of the New Capital Hotel. This building stone is well worthy of an interstate reputation. It is not only suited for constructional purposes, but also for curbing, bridges, culverts, paving, and railroad ballast and road work.

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*Register of the Kentucky State Historical Society, Frankfort, Kentucky, p. 75, Sept. 1904, also the Luminary, Lexington, Ky., May 23, 1827.

Bath County

The terranes of Bath County cover a much wider range of formations than is usually represented in a single county in Kentucky. The Ordovician, Silurian, Devonian and Carboniferous Systems or Periods are represented.

The Cincinnatian limestones of Ordovician age cover the entire northwestern part of the county. These limestones are flanked on the southwest by Silurian, then Devonian, and then Mississippian formations containing a few outliers of the Pennsylvanian system. The oldest rocks are therefore in the northwestern part of the county, and the youngest in the southeastern.

(1) The limestones are of gray or bluish gray color, and have been quarried for local use not far to the west of Owingsville, the county seat of Bath County. They weather fairly well.

(2) The Buena Vista sandstone of Mississippian age is represented at Caney Switch by 12 feet of fine grained, even textured, drab colored sandstone. The individual layers are separated by thin beds of soft, bluish gray shale, which materially reduces the expense in quarrying. The stone works easily and is the same in its essential characteristics as the freestone of Rowan County. Its close proximity to the railroad is in its favor for shipping, but the stone would have to be transferred to the Chesapeake & Ohio Railroad at Salt Lick, which would add to the cost of production.

(3) Buena Vista sandstones occur also around Olympian Springs, a few miles south of Olympia, but these are rather thin bedded, and their use would be local.

The Buena Vista sandstones of Bath County resist atmospheric decomposition well in their natural exposures. When freshly quarried, they are pleasing in their effect. As was pointed out in the discussion of the Buena Vista building stone in Rowan County, injudicious selection of the blocks leads to unsightly appearances in the finished structure. This effect can be seen in the lintels and facings of the courthouse in Owingsville. These cracked and iron stained blocks should have been rejected for constructional work and used as underpinning, curbing or paving. The careful selection of the better blocks

of the Buena Vista in Bath County as building stone cannot be too highly emphasized. The cause of the discoloration is probably due to microlites of pyrite, the sulphide of iron.

Boone County

The terranes of Boone County are all in the Ordovician system and belong to the Cincinnatian series. They are essentially thin bedded and shaly limestones, which are too friable for extensive use as building stone. A single quarry was reported near Burlington, the county seat, and is said to be used locally for underpinning, curbing, bridge construction, etc.

Bourbon County

The terranes of Bourbon County are all Ordivician in age. The formations in the central and western part of the county belong to the Champlainian series, and those in the eastern part to the Cincinnatian. The quarries, whether active or inac-

18. BOURBON COUNTY QUARRY.
This quarry is at Paris, Bourbon County, Ky. It shows the thickness of the individual beds.

tive, are all in limestone, more or less recrystallized. Some of them are sufficiently crystallized to be classed as marbles. Some of them receive a very good polish, and are well suited for constructional work, decorative interior work, bridges, culverts, curbing, railroad ballast and road work. They shade in color from pink to gray and light brown. They are of fine grain, even texture, and work easily. They hammer white, and often

the contrast is strong between hammered and polished surfaces. They are sufficiently thick bedded and persistent for large quarries to be opened They are so near the Louisville & Nashville Railroad that the quarried products may be handled with the minimum cost.

(1) *Paris Quarry.* This quarry is under the control of Bourbon County, and was also called the County quarry. It is situated within the city limits of Paris, the county seat, and not more than one-half mile east of the courthouse. It is also on the bank of Stoner Creek. The quarry opening is 400 feet in length, 250 feet in breadth, with a vertical working face of 40 feet. There is a rotary rock crusher here with a capacity of 200 tons per day.

(2) *City Quarry.* This quarry is situated one-fourth mile north of the courthouse on Seventh Street. It is also situated on Houston Creek. The quarry opening is approximately 500 feet in length, 250 feet in breadth, and 40 feet in depth. The rock crusher installed at this quarry has a capacity of 150 tons per day, and is of the jaw type. The stone is in every way similar to that in the Paris quarry.

(3) *North Middleton Quarry.* This quarry is situated 11 miles southeast of Paris on the Mt. Sterling pike. Approximately one acre of rock has been stripped of its overburden and a rotary crusher installed, with a 200 ton capacity.

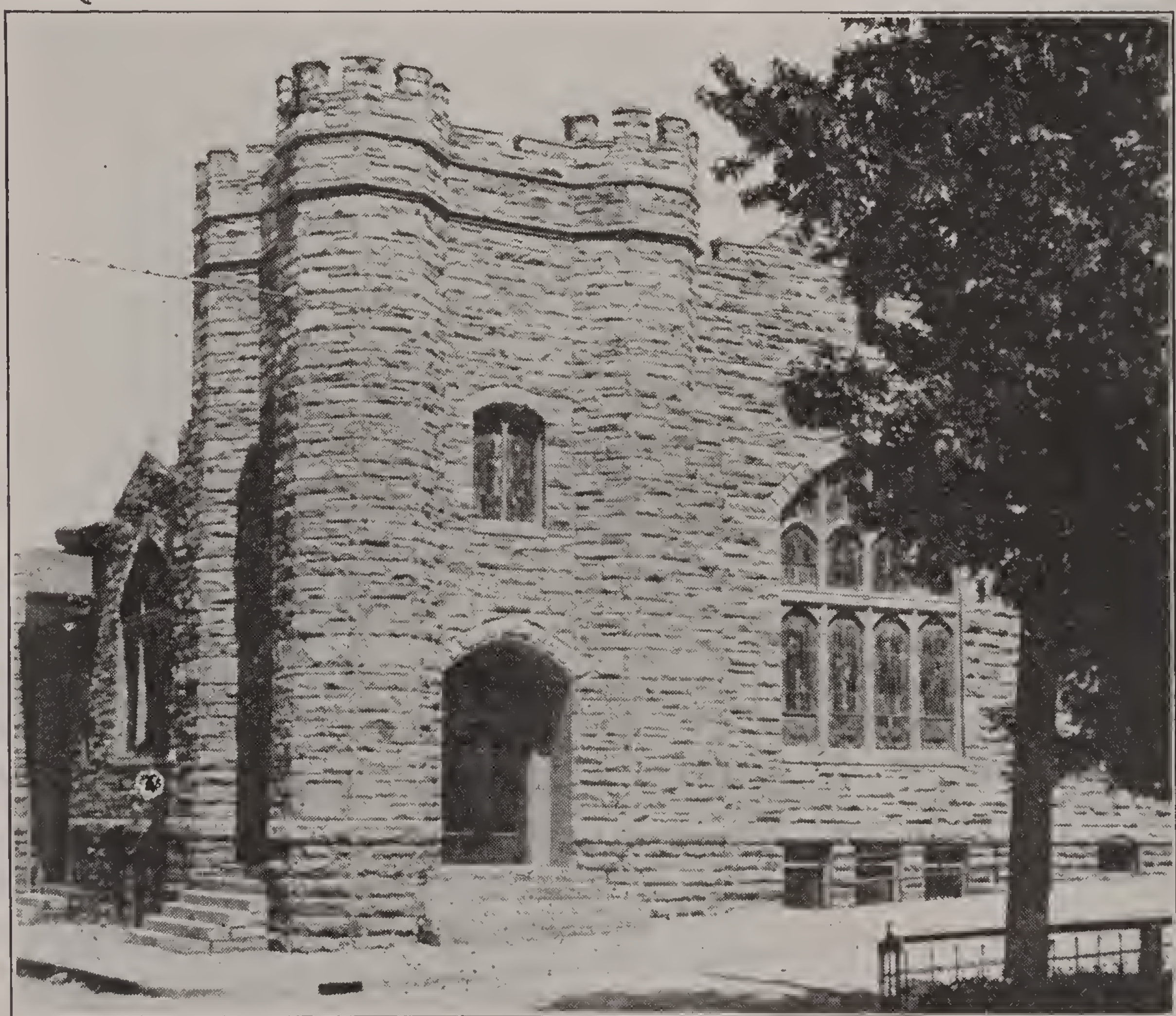
(4) *Cane Ridge Quarry.* This quarry is situated 4 miles north of North Middleton and 7 miles east of Paris on the Paris-Maysville or Flat Rock Pike. It is in the Cincinnatian formation, which is a very fine grained limestone, free from iron, and an excellent building stone. The quarry is 150 feet in length, 100 feet in breadth, with a working face 20 feet in height. The crusher has a daily capacity of 150 tons. The Cane Ridge building stone lies in a horizontal position, and beds outcrop along the ridge for a distance of some 4 or 5 miles. The steps for the courthouse were said to have come from this quarry. It has been used extensively for foundations, bridge abutments and curbing in North Middleton.

(5) This is also a Cane Ridge quarry, and is situated between the North Middleton quarry and the Cane Ridge quarry described as No. 3. The stone for the large buildings on the

E. F. Sims estate came from this quarry. The color of the stone here ranges from a buff or very light brown to a light gray or nearly white. It does not laminate on exposure to the atmosphere. It works freely in any direction and is susceptible of a polish. See the two analyses of limestone from Cane Ridge, Bourbon County, Chapter XI. One is non-dolomitic, and the other is dolomitic.

(6) *Courthouse Quarry.* This quarry is situated 1 mile east of Paris on the Maysville Pike. The stone has been used quite extensively in Paris in foundations, retaining walls, etc.

(7) *Ruddles Mills Quarry.* This is one of the oldest quarries in the county, and the village is one of the oldest in the State, for it is reported to have been settled soon after the arrival of Daniel Boone.



19. FIRST METHODIST EPISCOPAL CHURCH.
This church is at the corner of 7th and Pleasant Sts., Paris, Bourbon County, Ky. It represents Rowan County freestone.

(8) *Wood Brothers Quarry.* This quarry is situated on the Taylor farm, 1 mile northeast of Paris, but it is now aban-

doned. It carries some good building stone, and the stone quarried was used for foundation work rather than road building.

(9) A few miles north of Paris towards Cynthiana there was reported to be small quarries in the same limestone as that around Paris, but none of these were visited.

The Bourbon Agricultural Bank of Paris was erected in 1898 with the Rowan County freestone from Freestone. The First Methodist Episcopal Church South, corner of Seventh and Pleasant Streets, was built with Rowan County freestone from Farmer, and trimmed with Rockcastle County freestone. The Christian Church on High Street was built in 1902 with Rockcastle County freestone, and trimmed with Bedford, Indiana, oolitic limestone.

Boyle County

The terranes of Boyle County belong to the Ordovician, Devonian and Mississippian systems. The Silurian appears to be wanting. The Ordovician, which covers all the northern part of the county, is represented by both the Cincinnatian and Champlainian series, with the former in excess of the latter. The Devonian and Mississippian formations are confined to the southern part of the county. With the exception of the southern portion of Boyle County, where the black Chattanooga shales of Devonian age appear, the rocks are limestones and marbles.

The limestones are often of light gray color, rather coarsely crystalline, and with fairly even texture. Some of them show large plates of calcite with perfect rhombohedral cleavage and cavities partially filled with perfect crystals of dog-toothed spar, a variety of calcite. This phenomenon is well illustrated in the light gray upper beds of the Taylor Brothers quarry. If it were not for these cavities, which favor the lodgment of dust particles on dimension stone, this limestone would make a rather pleasing building stone. The rock is called a limestone rather than a marble, because the voids are not completely filled with recrystallized calcite.

Lexington limestones have been largely used in the construction of walls in Boyle County, especially near Danville, the county seat of Boyle County. The body of the wall is built of

limestone blocks laid in horizontal position, and then capped with thinner blocks set at an angle of 45 degrees with the wall body, which produces a very pleasing effect.

The marbles are found in the lower portions of the quarries. They are compact, massive, thick bedded and recrystallized limestones. They are of dark gray color and susceptible of a high polish. Their resistance to wear in inlaid floors would be superior to that of the soft, carbonaceous, non-crystalline limestones that are so extensively used. For panel work with a lighter border the effect would be pleasing.

(1) *Taylor Brothers Quarry.* This quarry is situated on the Stanford Pike, 1½ miles south of Danville. The length of the quarry is approximately 300 feet, the breadth is about 250 feet, and the depth is 55 feet. The upper portions are of light gray color and somewhat coarsely crystallized, while the thick bedded, massive lower portions are of dark gray color and crystallized. The stone from this quarry has been used for building purposes for seven years. The stone for the Bank Hudson in Danville came from it. It is well suited for abutments, bridges, culverts, railroad ballast, macadam.

(2) *Tevis and Ingram Quarry.* This quarry is situated on the Lexington Pike 2½ miles north of Danville. The stone is bluish gray color and the quarry has been in operation for three years. The stone is used locally for building and road work. It is not quite so large a quarry as that described as No. 1.

(3) This quarry is situated on the Lexington Pike some 4 miles north of Danville. The stone is in part of bluish gray color and in part nearly white. The rift and grain are perfect, and the stone splits easily into long slabs that could be used for building purposes.

(4) This quarry is only a short distance out from Danville, and is now inactive.

(5) This quarry is 4½ miles west of Danville on the Perryville Pike. The stone is bluish gray, and the height of the working face of the quarry is 20 feet.

(6) This quarry is on the Perryville Pike 6 miles west of Danville. The working face of the quarry is about 60 feet in height and the stone is used for road work.

(7) This quarry is on the Lebanon Pike about 5 miles southwest of Danville. The height of the quarry face is about 20 feet, and the stone is used for road construction.

(8) This quarry is near Parksville, 7 miles southwest from Danville. The stone is used for macadam.

(9) This quarry is between Danville and Junction City, and is now inactive.

(10) *W. J. Sparks Quarry.* This quarry is at Parksville on the Louisville & Nashville Railroad. It is one of the largest and best quarries in the county.

Bracken County

The terranes of Bracken County are all Ordovician. They essentially belong to the Cincinnatian series, but according to Prof. A. M. Miller, the Lexington stage of the Champlainian series is represented in a small area in the vicinity of Foster in the northwestern part of the county.

The limestones and shales are thin bedded, and can furnish limestones for local use only.

(1) *Foster Quarry.* This small opening near Foster is in the Lexington limestone. The beds are thin and the stone medium to gray in color.

(2) *Brooksville Quarry.* A small quarry near Brooksville, the county seat, has furnished stone for underpinning and curbing in Brooksville. It is probably in the Maysville formation.

(3) *Bradford Quarry.* This quarry is located at Bradford, a small station on the Chesapeake & Ohio Railroad west of Welsburg. The stone which has been used locally is a dark gray limestone.

Bullitt County

The terranes of Bullitt County present a wide range in age. The Ordovician, Silurian, Devonian and Carboniferous Periods are represented. The Cincincinnatian series are represented in the eastern part of the county. These are flanked on the west by the Silurian limestones, Devonian black shale, and Mississippian limestones.

(1) *Shepherdsville Quarry.* This quarry is near Shepherdsville, the county seat. The stone was used locally. This was in the limestone.

(2) There is a small opening near Belmont, Belmont Furnace, in a buff colored, fine grained sandstone, which has been called a building stone. It is a friable sandstone, with clayey matter as the cementing material. It appears too soft and brittle for constructional purposes, but unoxidized portions of the bed might prove otherwise. An analysis of the stone gave 94.75 per cent of silica and insoluble silicates. The same formation appears on the Knob at Bullitt's Lick.

(3) *Clermont Quarry.* This quarry is situated near Clermont, a small station on the Louisville & Nashville Railroad. The quarry is several hundred feet in length, with a working face of some 20 feet in height. The stone is of light gray color and a fine building stone.

(4) *Quarry Switch.* This quarry is at Quarry Switch, on the northeast side of the Louisville & Nashville Railroad. The quarry is in light gray limestone. It has furnished much building stone that weathers white. This quarry can be made several hundred feet in length. It is so near the railroad that there is no cost in transporting the stone to the point of shipment.

(5) *Stites Quarry.* This quarry is at Stites, a small station on the Louisville, Henderson & St. Louis Railroad, about 15 miles southwest of Louisville. The stone is used as railroad ballast.

Campbell County

The terranes of Campbell County all belong to the Ordovician system. They are, furthermore, all Cincinnatian, save a narrow strip along the Ohio River extending from the Pendleton County line nearly to California in Campbell County. The limestones are thin bedded, often with intercalated shale. They are of medium to dark gray color, and have been used locally in construction work, abutments, culverts, curbing, railroad ballast and macadam.

(1) *I. J. Croxson Quarry.* This quarry is situated 2 miles south of Newport on the Alexander Pike. The stone is more massive than in the other quarries and makes a fairly satisfactory

building stone. The stone for many retaining walls in Newport came from this quarry.

(2) *City Quarry.* This quarry is situated on Grand Avenue about 1 mile southeast of Newport, the county seat of Campbell County. The limestone at this quarry is somewhat shaly, but it has been used in retaining walls and foundation work. There is a crusher at this quarry with a capacity of 150 tons daily.

(3) *Clifton Quarry.* This quarry is 1½ miles south of Newport. The stone is all quarried by hand and used for foundation work. The foundation for the courthouse is said to have come from this quarry.

(4) *New Richmond Quarry.* This quarry is situated at New Richmond, some 20 miles southeast of Newport. It is a large quarry that has been used extensively for abutments, bridges and railroad ballast by the Chesapeake & Ohio Railroad.

Carroll County

The terranes of Carroll County are essentially confined to the Ordovician System, but there is a small outcrop of Silurian rocks in the extreme western part of the county. The Eden shales of the Cincinnatian series, which cover most of the county, are too thin bedded for building purposes. The area around Carrollton, the county seat, is heavily overburdened with sand and gravel. Some stone has been secured in the neighborhood of Carrollton, but no quarry was located.

There is one large quarry in Carroll County. It is situated 1 mile northeast of Worthville, on the west side of the Louisville & Nashville Railroad. The quarry is in the face of a high bluff, with the base of the quarry several hundred feet above the railroad. The quarry itself is about 400 feet in length, 100 feet in breadth, and 100 feet in height of working face. The individual beds are quite massive. Some of them have thicknesses ranging from 4 to 6 feet. The stone is of light gray color, and weathers white. Some of this stone can be seen in Worthville, where it has been used for foundation work. The most of the stone quarried has been used by the Louisville & Nashville Railroad for abutments, bridges and railroad ballast. The better beds are free from iron, and good dimension stone

can here be secured in large quantities. The altitude of the quarry above the railroad places it at a little disadvantage, unless the stone is shipped to the railroad by a gravity tram.

Clark County

The terranes of Clark County fall in the Ordovician, Silurian and Devonian systems. The Cincinnatian series of the Ordovician comprises a larger area than all the others combined. They cover the whole of the northern and central portion. The Champlainian series is represented in the southwestern part of the county and the Silurian and Devonian systems appear in the southeastern part. The outcrops are therefore prevailingly limestones. The black Chattanooga shale appears only in broken outcrops in a narrow belt in the southeastern part of the county. These are flanked on the west by the Niagaran formations. The limestones are thin bedded and inclined to be shaly. However, an appreciable amount of building stone for local use has been obtained in Clark County.

(1) *James Donahue Quarry.* This quarry is owned and operated by James Donahue. The quarry is situated 1 mile south of Winchester, the county seat of Clark County. The stone is of dark gray color and of even texture. The quarry is small. It is used as a building stone and is considered good for underpinning. It can be seen in the foundation of the W. G. Rice residence on College Street.

(2) *The Robinson Quarry.* This quarry is situated 1½ miles southeast of Winchester. The stone, which is of medium gray color, can be seen in the foundations of three homes on Hickman Street. It appears to weather well.

(3) *The Calamer Quarry.* This quarry is situated about 2 miles south of Winchester on the Boonesboro Pike. The stone is of medium gray color and has been much used in foundation work, abutments, bridges and road work. It is regarded as a good building stone.

(4) *Clark County Construction Company Quarry.* This quarry is situated on Broadway, within the city limits. The stone is very thin bedded, dark gray color, not suitable for building purposes, but used in railroad construction.

(5) *Slusher Quarry.* This quarry is on the Basin Springs Pike, 7 miles west of Winchester. The stone is of light gray color, uniform texture, works easily, and is the best building stone seen in the county. The stone is thin bedded, ranging from 7 to 10 inches. Large, massive blocks cannot be secured. The quarry opening is approximately 100 feet in length, 50 feet in breadth, and 30 feet in height of working face.

(6) *S. H. Rutledge Quarry.* This quarry is owned by Mr. S. H. Rutledge, civil engineer, Winchester, Ky. It is situated at the mouth of Goff's Branch of Dry Fork, where the Louisville & Nashville Railroad crosses Dry Fork near the village of Ruckerville.

This marble is gray in color, well calcitized and susceptible of a good polish. The sample submitted to the author contains some secondary chert, but not enough to interfere with the working of the stone. The rift and grain are good. This marble contrasts well with those of lighter shades, especially the mottled marbles, and it is well adapted for work in interior finish. According to Lucien Beckner, consulting geologist of Winchester, Ky., this marble has been used for outdoor construction in foundations, chimneys. walls, ice houses, etc., for more than a century, and the surface details of these old structures are as clear and distinct today as any imported stones seen beside them.

The marble is in the Winchester formation, which is of Mississippian age, and about 140 feet from its top. It consists of about 10 feet of hard limestone between softer limestones and shale. At the surface where weathered the marble breaks up into blocks about 1 foot in thickness, but the lower portions of the formation are much thicker bedded. The rock is fairly uniform in color and durability. It is prized highly by local stonecutters. To determine the amount of merchantable stone in the neighborhood of this quarry detailed field work is necessary.

(7) This quarry is about 1 mile east of Pine Grove, and is used for macadam.

(8) This quarry is about 1 mile northeast of Winchester and is used for macadam.

(9) This quarry is near the junction of the Skinners Mill and Wades Mill roads, about 2 miles north by northeast of Winchester, and is used for macadam.

(10) This quarry is 4 miles northeast of Winchester on the Wades Mill road, and is used for macadam.

(11) This quarry is 6 miles northeast of Winchester near Wades Mill, and is used for macadam.

(12) This quarry is at Skinners Mill, and is used for macadam.

(13) This quary is a little south of east of Winchester, about 5 miles from Winchester, and is used for macadam.

(14) This quarry is about 2 miles southeast of Winchester, and used for macadam.

(15) This quarry is about 3 miles southeast of Winchester on the road to Ruckerville, and is used for macadam.

(16) This quarry is on Four Mile Creek about 3 miles southeast of Winchester, and is used for macadam.

(17) This quarry is about 1 mile southwest of Pine Grove Station on the Chesapeake & Ohio Railroad, and is used for macadam.

(18) This quarry is about 2 miles southwest of Winchester on the road to Germantown, and is used for macadam.

It is not impossible that in several of these quarries limestones of medium gray color could be secured for building purposes.

The First Presbyterian Church on Main Street, Winchester, carries Rowan County freestone in the lower half of the edifice. The ashlar blocks in the upper half came from Rockcastle County from an old quarry on Round Stone Creek. The cut stone trimmings are from Bedford, Indiana.

Fayette County

All the terranes of Fayette County belong to the Ordovician system. With the exception of a few rather limited outcrops of the Cincinnatian series, Eden shale, they are all Champlainian in age. The High Bridge stage of the Champlainian series is brought into view in the southeastern part of the county along the Kentucky River wherever the river is on the northwest side of the Kentucky River fault. It also forms the bed and

the walls of Boone Creek for some little distance north of where the creek empties into the Kentucky River. The Lexington stage of the Champlainian series covers all the western part of the county, and the Cynthiana stage is well represented in the eastern part.

Fayette County is well situated for the production of large quantities of building stone. Its advantages are (1) the wide distribution of 5 different limestones or marbles, well suited for building purposes; (2) the fact that Lexington, the county seat, is a prominent railway center: (3) the abundance of bluffs of the Camp Nelson, Oregon and Tyrone formations along the Kentucky River, which furnishes the cheapest means for transportation of quarry products.

The Camp Nelson bed is massive, fine grained, even textured, mottled at times with lenses or narrow layers of dolomite.

20. KENTUCKY RIVER MARBLE.

This cut shows the thickness of the Oregon formation in a quarry near Clays Ferry, Fayette County, Ky.

The Oregon formation, or Kentucky River marble, is a dolomite, which is fine grained, even textured, buff colored, and often mottled. The Tyrone, or Kentucky marble, is massive, exceedingly fine grained, compact, breaks with a deep con-

choidal fracture, works easily, and is dove colored. The Lexington limestone is here a grayish granular to crystalline limestone that is sufficiently crystallized in some of the quarries to receive a good polish and find use in decorative interior work. In one quarry the limestone seems to be entirely recrystallized. If so, then this is a marble. A microscopic slide will be prepared from this quarry and studied under polarized light to ascertain the amount of metamorphism or molecular rearrangement in the calcium carbonate that has taken place at this quarry. It is one of the hardest limestones encountered in the State and its resistance to abrasion and shock appears to be due to the interlocking of the small calcite crystals. The Cynthiana in the eastern part of the county, gray or bluish gray in color, in some instances is sufficiently thick bedded to be quarried for building purposes.

(1) *Clays Ferry Quarry.* This quarry is situated about 13 miles southwest of Lexington near Clays Ferry. The quarry has been operated more or less intermittently for many years, and the stone shipped to Lexington for builidng purposes. It carries much excellent building stone. The quarry is in the Kentucky River marble and the Kentucky marble.

21. CLAYS FERRY QUARRY.
This cut shows the Kentucky Marble, Tyrone formation at the top, and the Kentucky River Marble, Oregon formation, at the bottom.

(2) *Grimes Mill Quarry.* This quarry is located at Grimes Mill on Boones Creek, about 12 miles southwest of Lexington. It is in the Oregon and Tyrone formations. This quarry

furnished much building stone for Lexington. The fluted columns and the pediment of the Old Capitol at Frankfort, Daniel Boone's monument in the Frankfort cemetery, and the monument of Henry Clay in the cemetery at Lexington, all came from this quarry. The Henry Clay statue in the Mines Building, Lexington, was cut from one piece of Kentucky River marble by a sculptor to whom Joel Hart was apprenticed. Several houses on Boones Creek and Grimes Mill were constructed with this stone. One of the houses was erected in 1813, and is still in a good state of preservation after more than 100 years of exposure.

22. RESIDENCE ON BOONES CREEK.

This residence on Boones Creek, Fayette County, Ky., was built of Tyrone limestone in 1813, and shows the value of the stone in construction work.

(3) This is a small quarry just east of the Richmond Pike, a little south of where the Grimes Mill road branches to the southeast from the Richmond Pike. It is in the blue limestone, and is used in road construction.

(4) *Jacks Creek Quarry.* This quarry is situated on Jacks Creek Pike, 12 miles south of Lexington. It is in the blue limestone and furnishes a good road metal.

(5) *Tates Creek Quarry.* This quarry is on Tates Creek Pike, just south of its intersection with Walnut Hill Pike, 8 miles south of Lexington. It is a good road stone.

(6) This quarry is on the Coletown and Kidville road, 9 miles south of Lexington. It furnishes good road metal.

(7) *Athens Quarry.* This quarry is on the Boonesboro Pike, 9 miles southeast of Lexington. It is a good road metal.

(8) *Boones Creek Quarry.* This quarry is 1 mile southeast of Athens on Boones Creek. It can furnish much fine building stone.

(9) *Boonesboro Pike Quarry.* This quarry is on the Boonesboro Pike, 8 miles southwest of Lexington. It is a good road stone.

(10) *Cleveland Pike Quarry.* This quarry is located on the Cleveland Pike, 1 mile north of the Athens quarry. It is a good road metal.

(11) *Armstrong Mill Quarry.* This quarry is on the Armstrong Mill Pike, 6 miles south of Lexington. It is a good road metal.

(12) *Tates Creek Pike Quarry.* This quarry is on Tates Creek Pike, 5 miles south of Lexington. It furnishes a fine building stone, as well as an excellent road stone.

(13) *Pricetown Quarry.* This quarry is situated at Pricetown on Todds Pike, 6 miles southeast of Lexington. The stone is too soft and shaly for even road work. It wears away very rapidly under constant traffic.

(14) *Tates Creek Pike Quarry.* This quarry is on Tates Creek Pike, 3½ miles south of Lexington. This quarry furnishes no screenings in the crushing of the stone for road construction. The screenings for topdressing the road in this vicinity are obtained from other crushers. The stone is the hardest of any found in the county, due to a greater interlocking of the calcite crystals. The stone is susceptible of a fine polish, and suited for building purposes. The thickest individual bed found

in this quarry is 2 feet. The stone for constructional work should be sawed. This quarry is owned by A. L. Hamilton of Lexington, Kentucky.

23. JESSE QUARRY, FAYETTE COUNTY, KY.
This quarry shows the thickness of the individual beds and the light gray color of the rock.

(15) *South Elkhorn Quarry.* This quarry is on the Harrodsburg Pike, 4 miles southeast of Lexington. It furnishes a good road metal.

(16) *Estell Quarry.* This quarry is situated just a little north of the Winchester Pike, 3 miles east of southeast of Lexington. It furnishes an excellent building stone that is much used in Lexington.

(17) This quarry is on the Bryant Station and Chilesburg Pike, some 6 miles east of southeast of Lexington. The screenings are exceptionally heavy, because the rock is too shaly for the best road work.

(18) *Aron Quarry.* This quarry is on the Briar Hill Pike, 7 miles east of Lexington. It furnishes a very good road metal.

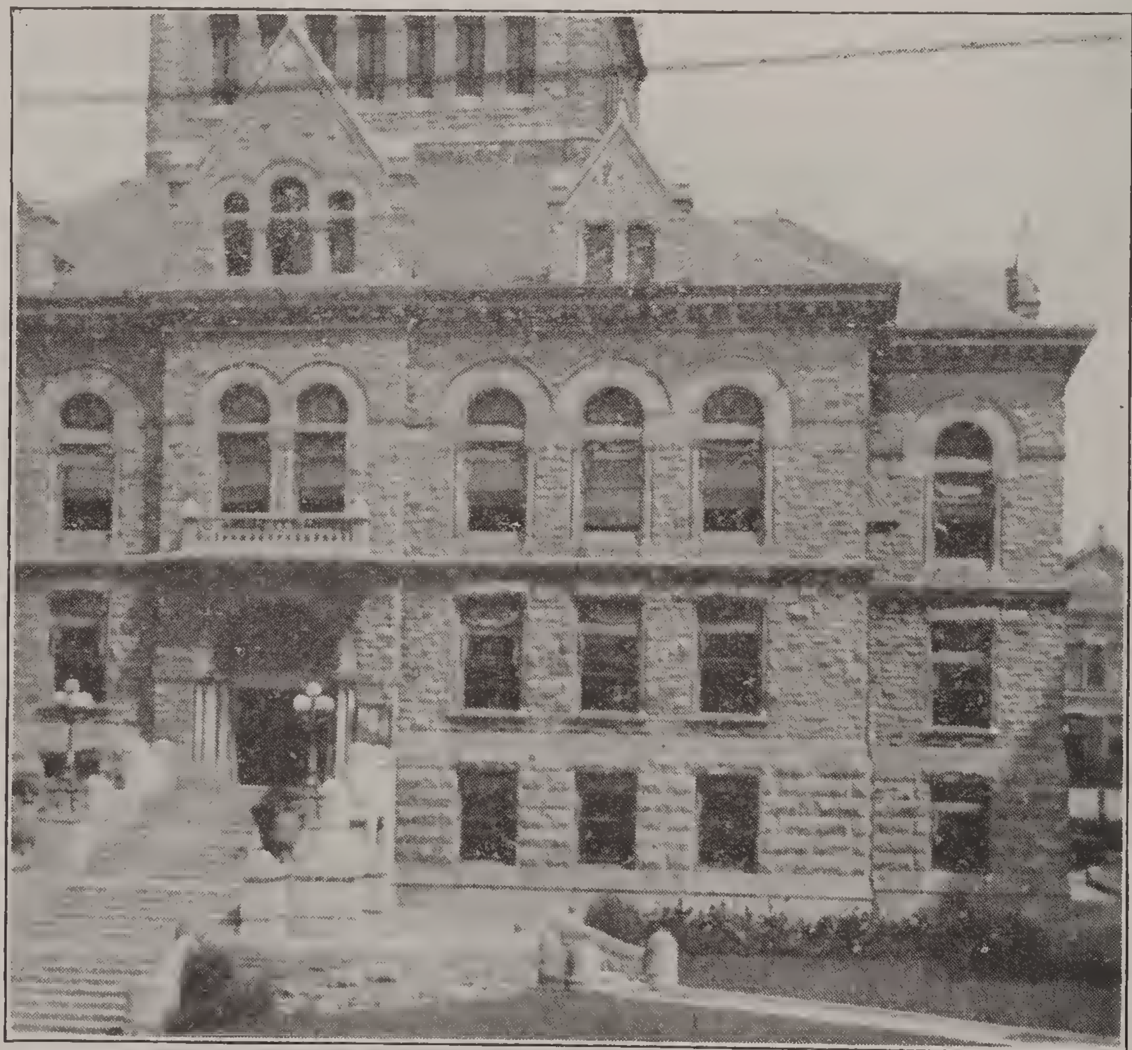
(19) *Briar Hill Quarry.* This quarry is on Briar Hill Pike, 6 miles east of Lexington. The stone is excellent for road construction.

(20) *City Quarry.* This quarry was situated within the city limits of Lexington, just off from South Limestone Street,

in the neighbrohood of the large warehouse. The foundations for the warehouse were quarried where the warehouse now stands. Much good stone for foundation walls was obtained here in the earlier history of building in Lexington. A part of the quarry area has been filled in by grading, and all quarry work abandoned.

(21) *Jones Quarry.* This quarry is on Spring and Pinard Pike, near the Bluegrass Park, 7 miles west of Lexington. It furnishes good stone.

(22) This quarry is one-half mile west of the city limits, but it is now abandoned. It has furnished good building stone for local use.



24. CITY HALL, LEXINGTON, KY.
This structure was built of Bowling Green white oolitic limestone and illustrates its architectural effect.

(23) *Workhouse Quarry.* This quarry is situated 1 mile west of the city limits, near the Louisville & Nashville Railroad. It carries some very good stone, a part of which has been used in foundation work.

(24) This quarry is situated near the Louisville & Nashville Branch of the Southern Railway System. It is too thin bedded, shaly and brittle to prove satisfactory in any work.

(25) *Viley Quarry.* This quarry is on the Louisville & Nashville Railroad 2½ miles northwest of Lexington. The stone is very good. This quarry has recently been purchased by Fayette County from the Louisville & Nashville Railroad.

(26) This quarry is on the Louisville & Nashville Railroad, 3½ miles northwest of Lexington. The stone is good, and it was reported that this quarry is to be opened up this fall on a large scale.

25. POSTOFFICE, LEXINGTON, KY.

This building shows the architectural value of Kentucky stone for massive construction.

(27) *Headley Quarry.* This quarry is situated on Russell Cave Pike, 1 mile northeast of Lexington. It furnishes handsome building stone for local use, and good road metal. The stone is gray in color, well crystallized, and susceptible of a handsome polish. Commercially, if not mineralogically, it is a marble. This quarry has been in continuous operation for many years.

(28) *Montrose Quarry.* This quarry is at Montrose, 3 miles east of Lexington. The stone is very good.

(29) *Russellville Pike Quarry.* This quarry is situated on the Russellville Pike, 1½ miles northeast of Lexington. It furnishes a very good medium gray building stone.

(30) *Haggin Quarry.* This quarry is on the Haggin estate, about one-half mile northwest of Muirs Station and about 6 miles northeast of Lexington. The stone in this quarry is both a building stone and a road stone.

(31) *Georgetown and Lexington Pike Quarry.* This quarry is on the Georgetown and Lexington Pike, 4½ miles north of Lexington. The stone is very good.

(32) This quarry is on the Ironworks Pike, 5 miles northwest of Lexington. The stone is used entirely for road work.

(33) *Daggin Quarry.* This quarry is on Elkhorn Creek, 6 miles northeast of Lexington. The stone is good.

26. CENTRAL CHRISTIAN CHURCH, LEXINGTON, KY.

This church is at the corner of Walnut and Short Streets, Lexington, Fayette County, Ky. The bluish gray, massive body is from the freestone quarries of Rockcastle County. The brown stone trimmings came from East Longmeadow, Mass. The polished granite columns came from Vinal Haven, Maine. A little Rowan County freestone appears in the edifice.

(34) *Huffman Mill Quarry.* This quarry is on Huffman Mill Pike, 6½ miles northeast of Lexington. The stone is good.

(35) *Greenwich Pike Quarry.* This quarry is on Greenwich Pike, 10 miles northeast of Lexington. This is an exceptionally good quarry for road metal.

(36) *Russel Cave Pike Quarry.* This quarry is on Russell Cave Pike, 10 miles northeast of Lexington. The stone is good.

(37) *Elkhorn Creek Quarry.* This quarry is on Elkhorn Creek, about one-fourth of a mile east of the Huffman Mill road, and about 6 miles northeast of Lexington.

(38) *Harris Quarry.* This quarry is on Elk Lick, about 1 mile below Clays Ferry. The bed of the Oregon formation is 6 feet in thickness. An analysis of this bed gave 59.88 per cent calcium carbonate, and 37.05 per cent magnesium carbonate. This brings the rock well within the range of the dolomites.

27. GOOD SHEPHERD CHAPEL, LEXINGTON, KY.
This chapel is on East Main Street, Lexington, Fayette County, Ky. It was built of limestone from quarries around Lexington.

Fleming County

The terranes of Fleming County cover a greater range in age than has been observed in most counties. They belong to the Ordovician, Silurian, Devonian and Mississippian systems. The entire western part is Ordovician. The Silurian series passes in a rather narrow belt across the county, through Hillsboro and Poplar Plains. The Silurian is flanked on the east by a very narrow belt of Devonian shales. The extreme eastern part, bordering Rowan County, is Mississippian.

The rocks therefore are widely varied in chemical composition, color, texture, degree of crystallization, and in the uses

to which they are best adapted. A larger number of quarries have been opened in Fleming County than in almost any other county in the State.

A wide variety of building stone is the direct result. The author could not ascertain that much stone had been shipped from the county. Yet in counties quite remote from Fleming, stone was found in foundations and monuments reported to have come from Fleming County. J. B. Faulkner cut and polished stone from this county many years ago.

(1) *County Quarry.* This quarry is situated 1 mile east of the courthouse at Flemingsburg, the county seat. It is in a dark gray limestone, which is used for road work.

(2) *City Quarry.* This quarry was also called Cemetery Quarry, for it is situated only a few rods from the cemetery gate. The quarry opening is about 300 feet in length, 200 feet in breadth, and 20 feet in height of working face. The beds vary somewhat in thickness. The upper beds are comparatively thin. The lower beds are from 3 to 4 feet in thickness, massive, crystallized, and of dark gray color. The dark gray color is flecked with small white crystals of calcite. The stone works easily into ashlar blocks and is of uniform texture. It cuts to a sharp edge. It hammers white, and receives a high polish. The contrast is marked between the hammered and polished surfaces. For monumental work, for which this marble is admirably suited, the face should be polished and then the surface cut away in such a maner as to leave the raised letters polished. The lettering could then be read at long distances. For purposes of massive construction, the ashlar blocks will present a uniform gray color, and be pleasing in its architectural effect. The stone is a marble, mineralogically, for it is completely recrystallized, and commercially, for it receives a high polish, and is well suited for decorative interior work. For inlaid floors in courthouses, banks and hotels, alternating with a lighter colored marble, this stone is one of the best. The same would hold equally true of paneling. A polished sample of this marble can be seen in No. 54, Museum of Kentucky Geological Survey, Frankfort.

(3) *County Quarry.* This quarry is situated on the Johnson Pike, 1 mile northwest of Flemingsburg, and is used for macadam.

(4) *Station Quarry.* This quarry is at the station of the Cincinnati, Flemingsburg & Southern Railroad. The stone is of light gray color, thick bedded, well crystallized, and weathers white. It makes a very satisfactory building stone for local use.

(5) *R. W. Meadows Quarry.* This quarry is reached by going west from Flemingsburg 1 mile on the Mt. Sterling Pike and then turning to the left and going ½ mile on the dirt road. The stone here is of light gray color and weathers white. It can be seen in the foundations of the old High School building, and in many retaining walls in Flemingsburg. It is a good building stone.

(6) *Model Road Quarry.* This quarry is 2½ miles northwest of Flemingsburg on the Fitch farm. It is a new quarry, but the stone is excellent for both constructional and road work.

(7) *County Quarry.* This quarry is on the Johnson Pike, 4 miles northwest of Flemingsburg. The stone is regarded as one of the best in the county.

(8) *Fleming Creek Quarry.* This quarry is situated 1 mile east of the courthouse. The quarry is small and inactive.

(9) *Red Sandstone Quarry.* This quarry is situated 12 miles east of the courthouse. It has been used in monumental and foundation work.

(10) *Hillsboro Quarry.* This quarry is just east of Hillsboro and about 15 miles southeast of Flemingsburg. The stone is bright red sandstone, and regarded good.

(11) *County Quarry.* This quarry is 9½ miles east of the courthouse. It is also in the red sandstone and used as macadam.

(12) *County Quarry.* This quarry is on Tupper Pike at Plummers Landing 10 miles southeast of Flemingsburg. It is also called the Ferris Lane Quarry. The stone is used for macadam.

(13) *Maley Quarry.* This quarry is 1 mile north of the courthouse. It is in limestone, and inactive.

(14) *McIlvain Quarry.* This quarry is situated near Cassidy Station, 2 miles southwest of Flemingsburg. The stone is of rich dark gray color, well crystallized, susceptible of a high polish, and is one of the best in the county. It should be classified as a marble.

(15) *Kirby Quarry.* This quarry is 4½ miles southwest of the courthouse on the Elizaville and Craintown Pike.

(16) *Bridgeport Quarry.* This quarry is situated 3 miles south of Elizaville, and is in limestone which would make a good building stone.

(17) *Burns Quarry.* This quarry is at Ewing, 7½ miles from Flemingsburg, and is a good building stone.

(18) *Stickrod Quarry.* This quarry is 10 miles northwest of the courthouse. It is in very good limestone, but was abandoned on account of water. The water could be pumped out and the quarry reworked.

(19) *Andrews Quarry.* This quarry is situated on the Flemingsburg and Upper Blue Lick Pike, 3 miles west of the courthouse. It is a good building stone.

(20) *Grannis Quarry.* This quarry is near No. 19, and is the same stone in all its essential characteristics.

(21) *Walker Quarry.* This quarry is situated on the Maysville Pike, 4 miles north of the county seat. It is now inactive.

(22) *Johnson and Kelly Quarry.* This quarry is on the Johnson and Kelly Pike, 4½ miles northwest of the courthouse. It is a very good building stone.

(23) *Bradford Quarry.* This quarry is on the Convict Pike, 4 miles west of Flemingsburg. It is a good building stone.

(24) *Mt. Carmel Quarry.* This quarry is situated on the Mt. Carmel Pike, 5 miles northeast of Flemingsburg. It is in the bright red sandstone, and the stone could be used for red stone fronts or retaining walls.

The Farmers Bank on Water Street has a stone front built of Fleming County limestone. The old Episcopal Church on Water Street, now used as a dwelling house, has foundations of local stone quarried and set in 1860. The old Presbyterian Church, built in 1812, has its foundation of local stone. At the residence of R. K. Dudley the California bungalow outside chimney was built of local stone. It presents a very pleasing effect. The retaining wall in front of the residence of Judge J. P. Harbeson, Main and Cross Streets, was built of local stone, 1870-1875. These citations illustrate the weathering qualities

of the Fleming County Building Stone. The sidewalks in Flemingsburg, containing blocks 10 feet in length and 3 feet in width, are of Rowan County freestone.

28. RETAINING WALL.

This wall is in front of the residence of Judge J. P. Harbeson, Flemingsburg, Fleming County, Ky. It was built of local stone more than 75 years ago.

Franklin County

The terranes of Franklin County belong entirely to the Ordovician system. The areas of outcrops are about equally divided between the Champlainian and the Cincinnatian series. The former flanks the Kentucky River on both sides across the entire county, and also both sides of its tributaries from both the east and the west. The Cincinnatian formations are the more widely distributed in the western part and the extreme northeastern part of the county.

The formations are all limestones, sometimes shaly in the upper layers of large quarries, but usually sufficiently thick bedded and massive for good building stone. In fact, in some of the quarries blocks of any dimension desired can be obtained. They range in color from the white or nearly white Kentucky Marble, Tyrone, to a dark bluish gray limestone on the higher altitudes. Some of these are sufficiently crystallized to be classified as marbles, and they are susceptible of a high polish. A polished sample of the medium gray, fine grained marble can be

seen in the museum of the Kentucky Geological Survy. For a full description of the Kentucky Marble see the description of Tyrone quarry under Anderson County. The quarries around Frankfort have furnished much stone for constructional work, abutments, bridges, culverts, curbing, paving, chimneys, etc. Also for railroad ballast and macadam.

29. J. B. BLANTON QUARRY.
This section of the J. B. Blanton Quarry, Frankfort, Franklin County, shows the relative thickness and horizontality of the individual beds.

(1) *J. B. Blanton Company Quarry.* This quarry is situated within the city limits on the Kentucky River, and on the east side of Frankfort, the county seat of Franklin County. The stone was quarried for the Old Capitol where the J. B. Blanton cement plant now stands. The value of this birdseye limestone or Kentucky Marble as a building stone is well illustrated by the Old Capitol, which has stood so many years exposed to the corrosive agents of the atmosphere, and which now shows so few ill effects from weathering.

The quarry is 550 feet in length, 150 feet in breadth, and 100 feet in height of working face. The J. B. Blanton office on the corner of Main and High Streets came from this quarry. Also the retaining wall at the entrance to the quarry, the retaining walls along the Kentucky River, in some places 40 feet high and 7 feet wide at the base, the Old Capital Hotel, which was destroyed by fire, the walls of the old Penitentiary, now the State Reformatory, many attractive homes in South

30. FRANKFORT STONE COMPANY QUARRY.
This quarry is at Frankfort, Franklin County, Ky. It shows good building stone.

Frankfort, and many distilleries and mills. The individual beds of this Kentucky Marble are about 6 feet in thickness, with a total thickness of 60 feet. This quarry is capable of putting its dimension stone on the market in such a way as to make this ideal building stone of interstate reputation. A large part of the quarry product now enters into road work, cement and concrete.

(2) *Workhouse Quarry.* This quarry is situated on the north side of the City of Frankfort and within the city limits. It is owned and operated by the city. The length of the quarry face is approximately 300 feet, with breadth the same. The height of the working face is 172 feet.

The stone has been used for curbing on many streets in the city, and for paving blocks. A portion of the quarry product is now manufactured into cement and concrete curbing. It is used in the construction of concrete houses and keeping the paved streets of the city in repair. There is a large crusher at this quarry. The large crushed stone is 3 inches in diameter, the intermediate grade 2 inches in diameter, and the smallest size is screenings used in road dressing.

31. INGLESIDE.
Residence of the late Col. Charles E. Hoge on the Frankfort-Versailles Pike, Franklin County, Ky. Photo by J. F. Cusick.

(3) *Frankfort Stone Company Quarry.* This quarry is situated on the River Road, just off Devil's Hollow Pike. W. J. Hulette is the owner and operator. The quarry has been in continuous operation for 16 years, save in 1919-1920. The length of the quarry is 165 feet, the breadth of the quarry 100 feet, and the greatest height of the quarry face 165 feet. The thickness of the individual beds sometimes attains to 30 feet. There is excellent building stone at both the top and the bottom of the quarry. The stone in the upper portion is bluish gray in color,

32. PAYNTER RESIDENCE.

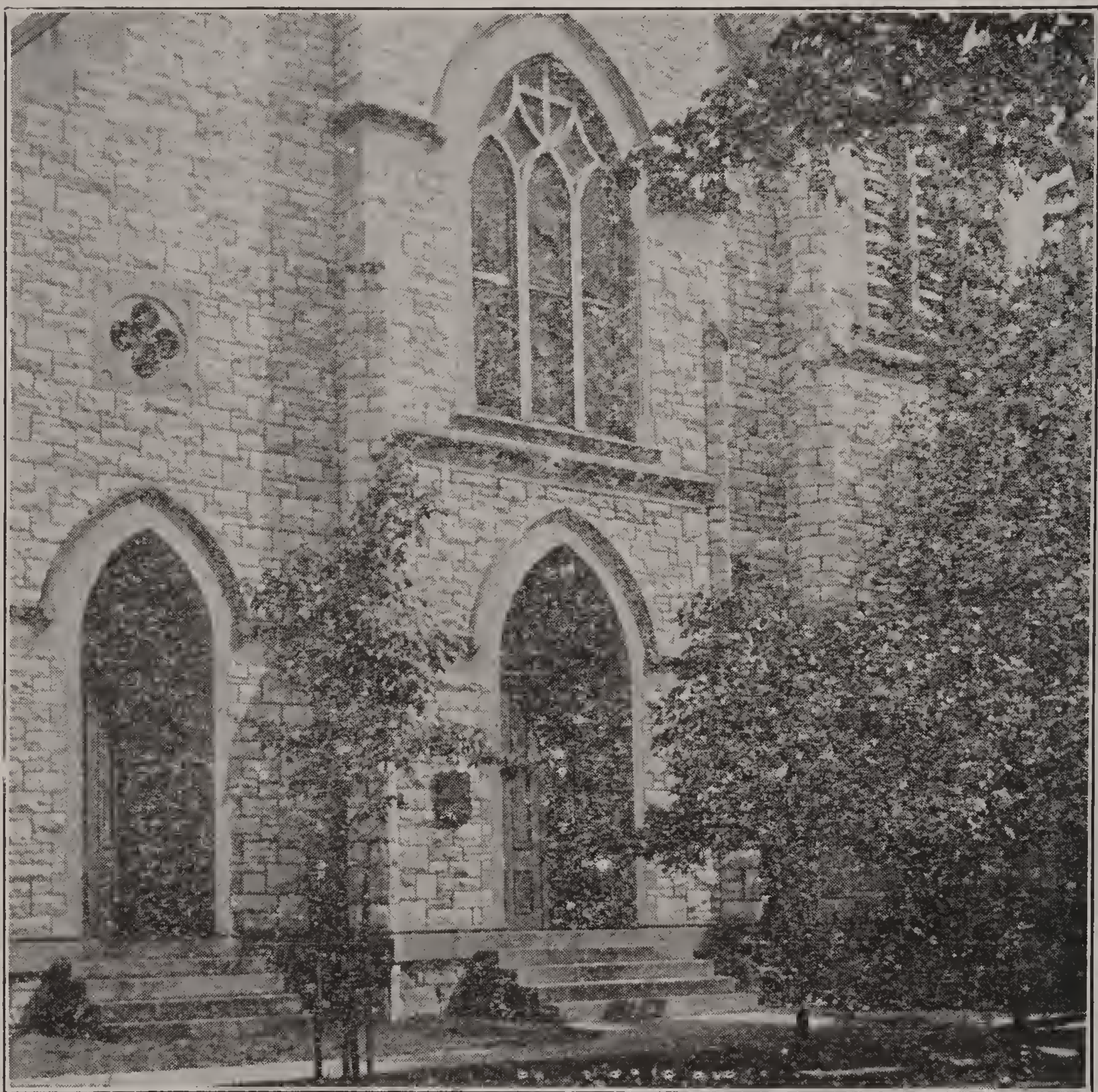
Home of the late Senator Thomas H. Paynter, 229 Shelby Street, Frankfort, Franklin County, Ky. The stone is Kentucky Marble.

33. HOWSER AND McDONALD RESIDENCES.

This cut shows the residences of E. W. Howser (left) and Frank McDonald, corner of Second Street and Capitol Avenue, Frankfort, Franklin County, Ky. It shows the effect of the Birdseye or Tyrone limestone in private residences.

and closely resembles the upper layers in the J. B. Blanton quarry. The stone in the lower portions of the quarry is gray-

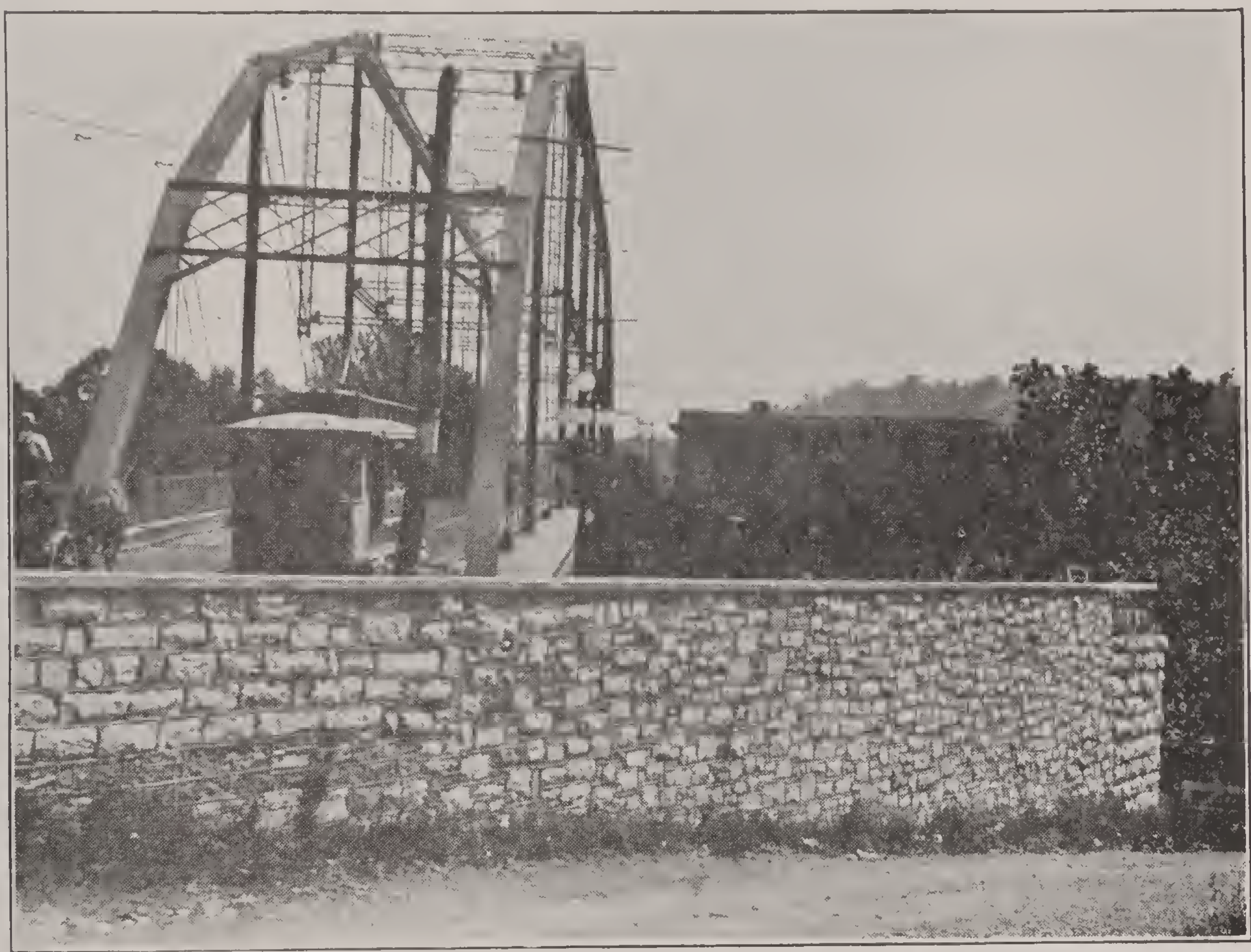
ish white to white in color, and closely resembles the lighter stone in the J. B. Blanton quarry.



34. METHODIST CHURCH, FRANKFORT, KY.
This church is on Washington Street, Frankfort, Franklin County, Ky. It was built of Tyrone limestone from the J. B. Blanton Quarry in 1843.

A part of the New Capitol building was constructed with stone from this quarry. It was estimated by Mr. W. J. Hulette that more than 100 private homes in and around Frankfort contain this stone. The handsome residence of George Feamster on Shelby Street is an illustration of the value of this stone in residential work. The rock crusher at this plant has a capacity of 150 tons per day. Four different sizes of crushed stone are manufactured. No. 1, 2 inches in diameter; No. 2, 1½ inches in diameter; No. 3, 1 inch in diameter; No. 4, screenings ¼ inch in diameter. The product of this quarry was used in

building the concrete blocks for the warehouses at Lock No. 4 on the Kentucky River. Two wheelbarrows of screenings to 1 bag of cement meets the State requirements for road construction. This equals 4 to 1 by weight.



35. GUARD WALL, FRANKFORT, KY.

This wall is at the north end of the St. Clair Street bridge over the Kentucky River at Frankfort, Franklin County, Ky. The stone is mostly Tyrone limestone.

The main body of the decorative walls along the Louisville Pike came from this quarry, but the curbing and decorative top came from the Kate Williams quarry.

(4) *Kate Williams Quarry.* This quarry is situated on the Devil's Hollow Pike, about 1¼ miles west from Frankfort. The stone is of bluish gray color, and a good building stone. It corresponds to the upper layers at the quarry of the Frankfort Stone Company. This stone was used in building Lock No. 6 on the Kentucky River, and also the fence on the Colonel E. H. Taylor property.

(5) *Lillis and Harrod Quarry.* This quarry is situated 1 mile northwest of Frankfort, on the Bald Knob Pike. The stone is of bluish gray color, and a good building stone.

36. STATE REFORMATORY WALL, FRANKFORT, KY.

This cut shows a section of the wall of the State Reformatory, Frankfort, Franklin County, Ky. It is reported to have been built more than 100 years ago.

(6) This quarry is situated directly south of the city, just beyond the entrance to the Louisville Pike.

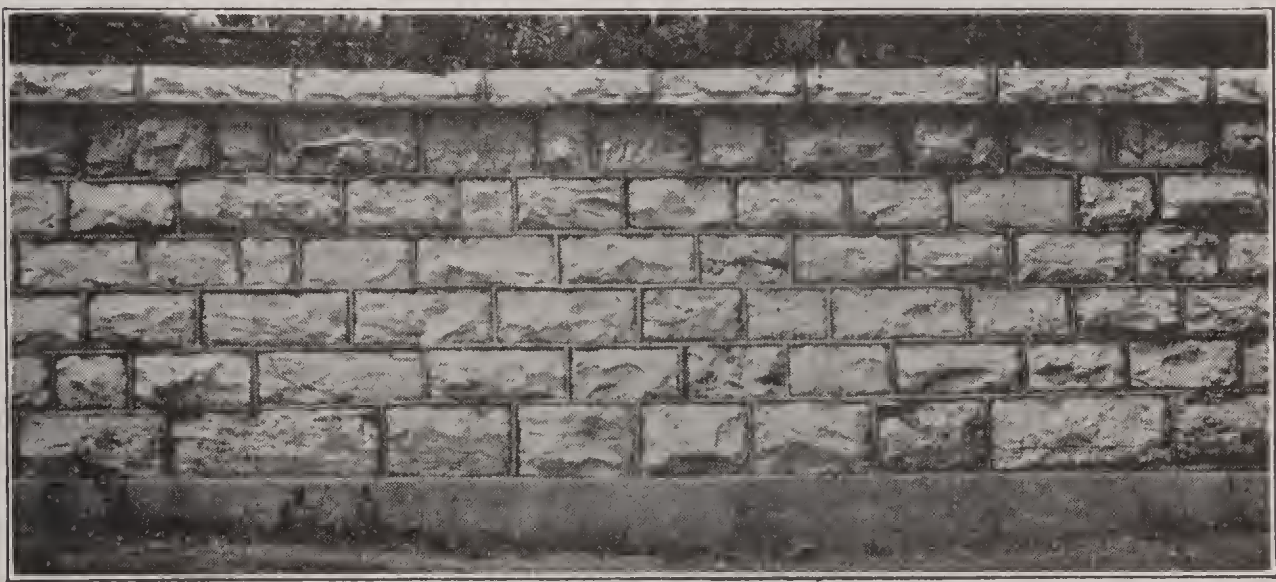
(7) An old quarry was reported at Lock No. 4 on the Kentucky River, about 1 mile north of Frankfort. The stone was used in building the lock and dam at this place.

(8) This quarry was located on the old John R. Scott farm, some 4 or 5 miles east of Frankfort.

(9) This quarry is in the neighborhood of South Elkhorn, about the same distance from Frankfort.

Dr. David Dale Owen, former State Geologist, says of these quarries, Nos. 8 and 9, that they furnish the best building stone

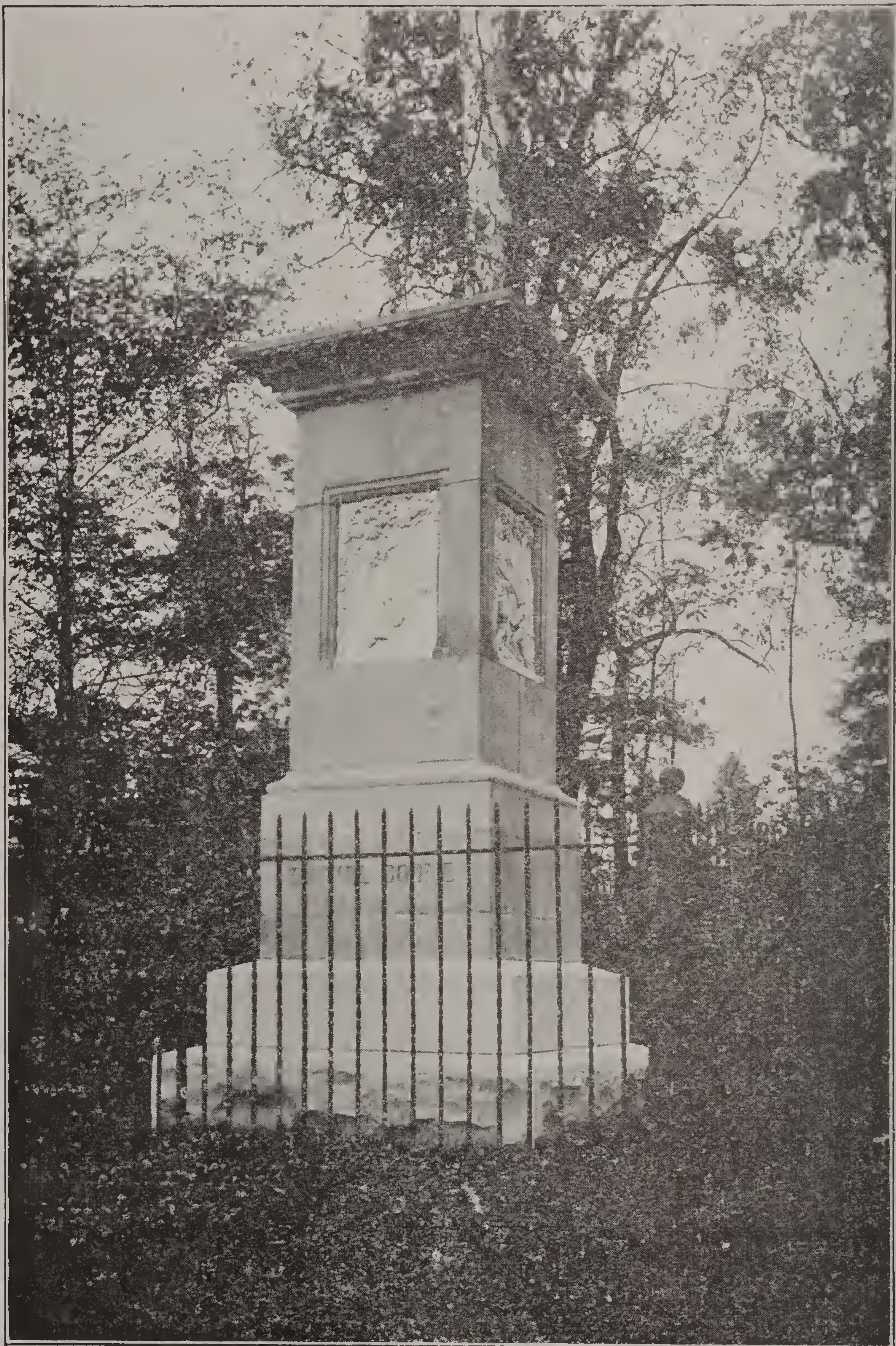
that can be obtained from the blue limestone formation in the eastern part of the county. Dimension stones of from 1 to 5



37. RETAINING WALL, FRANKFORT, KY.
This wall is at the intersection of Main and High Streets, Frankfort, Franklin County, Ky. All the blocks are Tyrone limestone.

38. THE OLD CAPITOL, FRANKFORT, KY.
The fluted columns are from the Oregon formation. The dimension blocks are from the Tyrone formation. Photo by J. F. Cusick.

feet thick can be secured. This rock has been used in foundations for some of the best houses in the county, as well as for



39. DANIEL BOONE MONUMENT, FRANKFORT, KY.

This monument is in the cemetery at Frankfort, Franklin County, Ky. It was cut from the Kentucky River Marble. Photo by J. F. Cusick.

40. THE GOVERNOR'S MANSION, FRANKFORT, KY.
This mansion was erected with Bowling Green white oolitic limestone and illustrates well its architectural effect.
Photo by J. F. Cusick.

gate posts and steps, and has stood well the test of years in trying situations. It splits well, and when freshly quarried it is easily worked with a chisel, and takes a partial polish, but it is rather too porous to make a good marble. This stone not only stands the action of frost, but even strong radiating heat, without cracking, placed in the jambs of fireplaces.

(10) *Dr. John P. StewartQuarry.* This quarry is located on the Stewart farm near Farmdale. Besides other ordinary structural limestone it produces a semi-crystalline crinoidal limestone which takes a beautiful polish, and is therefore a commercial marble. It would be best suited for interior finish as a small amount of carbonate of iron in the crinoid stem would cause it to weather to a rusty brown in exposed positions.

Gallatin County

The terranes of Gallatin County all belong to the Ordovician system and the Cincinnatian series. This series seems to be divided between the Eden shales and the Maysville limestone. The former are too thin bedded and shaley to furnish building stone. The latter sometimes produces beds sufficiently thick bedded for local use. A quarry in thin bedded limestone was reported to exist a few miles south of Warsaw, the county seat.

Garrard County

The terranes of Garrard County belong to the Ordovician, Silurian, Devonian and Mississippian systems. Ordovician terranes exceed in area the other three systems combined. The northwestern portion of the county is in the Champlainian series. The central portion is Cincinnatian. These Ordovician rocks are flanked on the southwest by a narrow belt of the Silurian limestones, then by a narrow belt of Devonian shale, which is in turn flanked again by the Mississippian.

The building stones of the county are limestones and marbles. The white birdseye limestone or Kentucky Marble attains a thickness of about 50 feet. The gray and mottled marbles about 30 feet, and the buff building stones about 10 feet. These rocks were quarried as early as 1850 for foundation work, outside stone chimneys, fire jambs and road construction. The pikes leading out of Lancaster, the county seat, are mostly built of the gray and blue limestones.

(1) *Bryantsville Quarry.* This quarry is situated near Bryantsville, and about 10 miles northwest from Lancaster. The bluffs here rise so high and are so long that the supply of stone seems to be inexhaustible. The stone ranges in color from white to light gray, and is of uniform texture. It has been used for building purposes and macadam.

(2) This quarry is near Lancaster, and has furnished stone for foundation work and road construction.

Grant County

The terranes of Grant County are all Ordovician. For the most part they belong to the Cincinnatian series, but the Champlainian, Cynthiana, appears in a narrow belt in the southwestern part of the county. The Cincinnatian formations are divided between the Eden shales in the southern part and the Maysville limestone in the northern part of the county.

The limestones are thin bedded, of medium to dark gray color, and no quarries are known to produce building stone other than for local use around Williamstown, the county seat. The Queen & Crescent Route of the Southern Railway System passes north and south through the center of the county, and has used the local thin bedded limestone for railroad ballast. The thin beds are used also for abutments, bridges, curbing and road work, but this use is purely local.

Harrison County

The terranes of Harrison County are all Ordovician in age. The Champlainian series appear in a narrow belt along the South Fork of the Licking River and on both sides of the tributaries to South Fork from the west. The Lexington and Cynthiana stages are both represented. The Cincinnatian formations, Eden shales, cover the entire eastern and western portions of the county.

The building stones of Harrison County are limestones and marbles. The limestones are of light gray and medium gray color. The marbles are of medium gray and dark gray color. They are all fine grained and even textured.

The marbles are well crystallized and susceptible of a high polish. They cut to a sharp edge, hammer white, and the contrast is strong between hammered and polished surfaces. The

stone is not thick and heavy bedded, like the limestones in Warren County, but they are sufficiently thick bedded in several quarries to provide good dimension blocks. The better beds range from 1 to 3 feet in thickness. A polished sample of this marble can be seen in Specimen No. 49 in the museum of the Kentucky Geological Survey. The marble blocks should be sawed to prevent wastage. The stone is well adapted for constructional work in ashlar blocks. In decorative interior work it would be especially pleasing.

41. J. Q. WARD QUARRY, CYNTHIANA, KY.
This quarry is at Cynthiana, Harrison County, Ky. The thickness of the beds of limestone can be seen back of the broken stone in the foreground.

(1) *J. R. Poindexter Quarry.* This quarry is situated about three-fourths of a mile southeast of Cynthiana, the county seat of Harrison County. The length of the quarry is 300 feet, the breadth is 50 feet, and the altitude of the working face about 20 feet. The stone was used in the foundation of the new city hospital, and other buildings within the city. It is also easily worked into paving blocks, and is now largely used in the construction of the new Lair Pike. The gray and bluish gray varieties were both used in the foundation of the new school building. The gray crystalline marble is the best produced in the quarry.

(2) *The McGibben Quarry.* This quarry is about three-fourths of a mile south of Cynthiana. This quarry furnished the

stone for the county jail built many years ago. It weathers a uniform light gray. The stone has also been used in a large number of retaining walls and dams.

(3) *Jack Lemons Quarry.* This quarry is about 1 mile southeast of Cynthiana. It produces a light gray building stone that weathers nearly white.

42. J. R. POINDEXTER QUARRY, CYNTHIANA, KY.
This quarry and crusher are at Cynthiana, Harrison County, Ky. The quarry is in dark gray, well crystallized limestone.

(4) *Pleasant Street Quarry.* This quarry furnished the stone for the Methodist Episcopal Church South. The quarry has now been abandoned, although it still contains good building stone.

(5) *William Redmond Quarry.* This quarry is situated 1 mile east of Cynthiana, on the old Lair Pike. It is now owned by Jack Lemons. It furnished the stone for the Christian Church on the corner of Main and Mill Streets, the trimmings of which are Rockcastle freestone. This quarry is now idle.

(6) *Belmont Quarry.* This quarry is 1 mile west of Cynthiana. It has furnished quite a little stone for local building purposes, but it has been abandoned on account of a heavy overburden that demanded too great an expense in stripping.

(7) *Quincy Ward Quarry.* This quarry is situated about 2 miles southeast of Cynthiana on the new Lair Pike. The stone is grayish white and crystalline. It is an excellent building

stone, and is said to be one of the best road building rocks in the State. It has a crusher and the product is used in the construction of the new Lair Pike. It receives a very handsome polish.

(8) *The County Quarry.* This quarry is on the Oddville Pike, one-half mile east of Cynthiana. It carries a crusher and the stone is used on the county roads.

43. CHRISTIAN CHURCH, CYNTHIANA, KY.
This church is on Main Street. Cynthiana, Harrison County, Ky. The stone came from the Belmont Quarry.

(9) *Oddville Quarry.* This quarry is on the Oddville Pike, 4 miles east of Cynthiana. The stone is being used on the Oddville Pike.

(10) *Helms Quarry.* This quarry is on the Falmouth Pike, 2 miles north of Cynthiana. It is inactive.

The stone in the Episcopal Church, built in 1856, came from an abandoned quarry near the old cemetery on North Main treet. The foundation of the Crown Jewell Mill, said to have been built more than 100 years ago, is of local stone. The stone is still well preserved.

Henry County

The terranes of Henry County all belong to the Ordovician system. The Champlainian series, Cynthiana, is represented by

a small area in the northeastern part of the county along the Kentucky River. The Cincinnatian series is divided between the Eden shale in the southeastern part and the Maysville and Richmond stages which cover the remainder of the county.

As a rule, the formations are thin bedded and would produce building stone only in limited quantities for local use. Along the Kentucky River, which forms the northeastern boundary of the county, the bluffs rise over 350 feet above low water, and in their lower portions good building stones can be secured.

(1) *Lockport Quarry.* This quarry is located at Lockport, on the Kentucky River. The quarry was opened to furnish stone for the lock and dam at Lockport. It has been used for other building purposes. The stone is sufficiently crystallized to receive a good polish.

(2) *Gestville Quarry.* This quarry is situated at Gest, formerly Gestville, on the Kentucky River. The stone was quarried for the construction of the lock and dam at Gest. It possesses the same characteristics as the building stone at Lockport.

(3) *Jericho Quarry.* This quarry is near the small station at Jericho, on the Louisville & Nashville Railroad. The stone has been used as ballast and macadam.

(4) *Pendleton Quarry.* This quarry is situated at Pendleton, a small station on the Cincinnati Division of the Louisville & Nashville Railroad. The stone is used for ballast and macadam.

(5) This quarry is near New Castle, the county seat of Henry County. The stone was quarried for underpinning in New Castle.

Jefferson County

According to the State geologic map, the terranes of Jefferson County are widely varied in age. The extreme eastern portion of the county lies in the Ordovician system, Cincinnatian series. The Silurian system, Niagaran series, Louisville sub-stage, flanks the Cincinnatian formations on the west. These terranes fall to the east of the central part of the county. Perhaps a part of the territory mapped as Cincinnatian is in reality Niagaran. The Devonian system traverses the central part of the county in a general north and south direction. It is not confined to the Ohio and Chattanooga shales of the Upper Devo-

nian, for the Middle Devonian, with its Columbus limestone, has extensive development. It forms the main portion of the ledge, which has produced the falls of the Ohio, at Louisville, which represents one of the best ancient coral reefs in America. The southwestern portion of the county carries the Mississippian system of rocks. The Cuyahoga shale, with intercalated sandstones, and the Logan stages, are represented. The Logan on Holtsclaw Hill south of Louisville attains a thickness of 20 feet.

The limestones of Jefferson County furnish most admirable building stone. They are not only suited for purposes of massive construction, but also for abutments, bridges, retaining walls, foundations, outside chimneys, fire jambs, fences, etc. Some of them are used for railroad ballast, paving blocks and macadam. Some of them contain 10 per cent or more of silica, with a sufficient amount of clayey matter so that when the stone is burned and ground, it has the property of setting. This rock is the hydraulic limestone. Some of the limestones are burned for lime, which may be used both for building and agricultural purposes.

44. CITY WORK HOUSE QUARRY, LOUISVILLE, KY.
This quarry is in Louisville, Jefferson County, Ky. The cut shows the thickness of the individual beds and the methods of hauling the stone from the quarry floor.

The principal quarries on Beargrass Creek in the eastern environs of Louisville are in the Louisville Limestone. It ranges

in thickness from 60 to 75 feet, with the individual beds varying from 1 to 7 feet in thickness. This greater thickness is well illustrated in the City Work House Quarry, 3 miles east of the courthouse at Louisville, the county seat of Jefferson County.

The upper portion of the Louisville limestone is of bluish gray color, fine grained, even textured, siliceous, argillaceous, and highly fossiliferous. It is the chief source of the Louisville limestone fossils, which are very abundant. Near the center of the Louisville formation there occurs a thick, even bedded, magnesian limestone. This stone is of light bluish gray color, very fine grained, with perfect rift and grain, works easily and weathers buff. It is microcrystalline, and susceptible of a polish. This is considered by the author of this report the best building stone of Jefferson County. It is extensively used for this purpose, and for foundations, retaining walls, and curbing. As seen in the eastern part of Louisville, it produces a most pleasing effect. The lower portions of the Louisville limestone are of darker gray color than the top layers, and much harder than any of the other layers. Therefore, these lower layers make better paving blocks, curbing, flagging and macadam.

45. HENRY BICKLE QUARRY, LOUISVILLE, KY.
This quarry is in Jefferson County, Ky. It shows the thickness of the individual beds.

The cherty members are the only layers of the Louisville limestone that are not extensively used for building purposes or curbing, but even the cherty layers are often seen in the founda-

tions of some beautiful residences on Third and Fourth Streets, north of Broadway. The uniform, soft, slightly bluish to bluish gray tints in the Louisville limestone makes it a favorite for the construction of churches, in which it presents a very pleasing exterior appearance.

The upper half of the Laurel dolomite, which is the second member below the Louisville limestone, and also a member of the Niagaran system, contains a high grade building stone. It is not as thick bedded as the Louisville limestone, for the individual layers are from 1 to 2 feet in thickness. On account of the evenness of the bedding, and the good rift in the stone, it can be easily quarried and manufactured into dimension stone for building purposes with a minimum expenditure. The stone is of very light gray color, with a tendency to weather to a light buff. It is very fine grained, and of uniform texture. It is a building stone of fine quality.

The lower layers of the Laurel dolomite are much harder, darker in color, and one bed attains a thickness of 16 feet. It is well suited for curbing, paving and macadam, and can be used in foundation work.

The Saluda limestone, which is the uppermost member of the Cincinnatian system in Kentucky, is an argillaceous limestone, which has been used on a small scale for heavy masonry construction. It is of uniformly bluish gray color on its freshly fractured surfaces, but upon long continued exposure to the atmosphere it shows a rather pleasing banding of light buff, yellowish and brown colors. It is a very fine grained, even textured, soft, easily worked, thick bedded, argillaceous limestone. This bed attains a thickness of 30 feet. For this reason, and because the limestone is so soft and easily worked, large dimension stone can be obtained for purposes of heavy masonry.

The stone should always be set in such a way that the greatest pressure will be at right angles to the planes of bedding, for these planes of lamination are planes of weakness. The abutments of the bridge on the Louisville & Nashville Railroad, one-half mile northwest of Eastwood, are Saluda limestone. These abutments show no signs of flaking or crumbling, although they have been exposed to the corrosive agents of the atmosphere for

many years. This rock has also been used at the various locks of the Louisville canal.

The thin beds of the Liberty and Arnheim formations, substages of the Richmond, are used locally for retaining walls, outside stone chimneys, fences, etc. The thick bedded Waynesville formation, which lies between the Liberty and Arnheim members, suggests its possible use for building purposes. However, it lacks the even grain of the other formations described, and the bedding may not be uniform. Its actual value would be difficult to estimate until some quarry is opened in this formation for other purposes than road work.

According to Charles Butts, the Kenwood and Holtsclaw sandstones should afford building stone for a limited local use. No quarries were seen by the author in these last two formations.

46. ABANDONED QUARRY.
This quarry is near the city water works of Louisville, Jefferson County, Ky. It shows reserve building stone.

All of the limestones described above, whether dolomitic or otherwise, are used extensively for macadam. The largest shipping quarry outside the City of Louisville is at Tucker, a station on the Southern Railroad, Louisville and Lexington Branch. Temporary quarries have been opened for road work in many parts of the county, and limestone for this purpose is very abundant.

The Jeffersonville limestone which caps the hills and the spurs in Jefferson County is sufficiently abundant and sufficiently low in content of magnesium carbonate to permit its use in the manufacture of Portland Cement. For this purpose, a limestone should not be utilized which contains more than 5 per cent of magnesium carbonate, and preferably less than 3.5 per cent.

The Silver Creek Hydraulic Limestone was formerly used in the manufacture of natural cement. It underlies the City of Louisville. The quarry was situated at the foot of 14th Street, near the Pennsylvania Railroad bridge.

The activities have been so intense in the quarry industry in Jefferson County that it seems impractical to attempt to list all the quarries. The smaller quarries change ownership so often that it might be difficult to locate them in a few years by the names that now might be given.

47. PRESBYTERIAN THEOLOGICAL SEMINARY.
This Seminary is at 109 East Broadway, Louisville, Jefferson County, Ky. It was built of Bowling Green white oolitic limestone.

(1) *City Work House Quarry.* This quarry is situated 3 miles east of the courthouse. Some of the individual beds are quite blue on their fresh surfaces; others are of light bluish

gray color. The thickest individual bed was 7 feet. Several beds were 5 feet in thickness. The total length and breadth of the quarry were approximately equal, 750 feet. The height of the present working face was 20 feet. There is much excellent building stone at this quarry.

The crusher at this quarry has a capacity of 100 tons per day. Four different sizes of stone are manufactured. No. 1, 2 inches in diameter, used in road bed; No. 2, 1 inch in diameter, used as a binder; No. 3, ½ inch in diameter, used for covering and patch work; No. 4, dust, used for top dressing.

48. CARNEGIE LIBRARY, LOUISVILLE, KY.
This cut shows the entrance to the Carnegie Library, Louisville, Jefferson County, Ky. The library was built of the Bowling Green white crystalline limestone.

(2) This quarry is some 30 rods beyond the Work House. It contains the same type of limestone as the Work House Quarry. The walls of the Work House were constructed of stone from this quarry about 50 years ago. The walls have weathered to a white or slightly yellowish white color, and prove the value of the stone in architectural work. The quarry was abandoned for want of ownership of more quarry land, but the supply of stone is not exhausted.

(3) *Henry Bickle Quarry.* This quarry is situated 4 miles east of the courthouse on Raymond Avenue, between Frankfort Avenue and the Work House road. There are 15 acres in the quarry. The stone is excellent for building and road work. The stone for the addition to the beautiful Strathmore home on the Taylorsville road came from this quarry.

(4) *Stengle Quarry.* This quarry is in the same neighborhood, and it furnished the stone for the 11 visible courses in the home of Lawrence Siebert, 2141 Spring Street.

49. CHRIST CHURCH CATHEDRAL, LOUISVILLE, KY.
This church is on South 2nd Street, Louisville, Jefferson County, Ky. It was built of Louisville limestone. Plate date 1822.

(5) *Shank Quarry.* This quarry is in the eastern part of Louisville. It produces most excellent building stone from the Louisville limestone.

(6) *Wm. F. Woodruff Quarry.* This quarry is some 4 miles northeast of the courthouse, near the Blanken Baker Sta-

tion on the Pewee Valley electric line. It is the largest quarry around Louisville.

(7) *Jim Taylor Quarry.* This quarry is 2 miles northeast of the courthouse on the interurban trolley line near Water Works Station.

(8) *Atkins and Staebler Quarry.* This quarry is at Douts Point, 2 miles southeast from the courthouse, and about ½ mile from the city line.

(9) *Camp Taylor Quarry.* This quarry is situated on the Paducah or Poplar Level road, 4 miles south of the courthouse. It is a little north of Camp Taylor. The stone was used in the construction of the camp.

(10) *Charles Bameister Quarry.* This quarry was also called the Pewee Valley Quarry. It is owned and operated by Chas. Bameister. It is about 20 miles east to northeast of Louisville. It has a crusher with a 100-ton capacity.

50. CITY PENITENTIARY, LOUISVILLE, KY.

This cut shows the city penitentiary with its enclosing wall built of stone from the old city work house quarry, 1876. Louisville, Jefferson County, Ky.

(11) *L. & N. Quarry.* This quarry is at Avoca, on the Louisville & Nashville Railroad, 17.3 miles east of Louisville. The stone is used for railroad ballast.

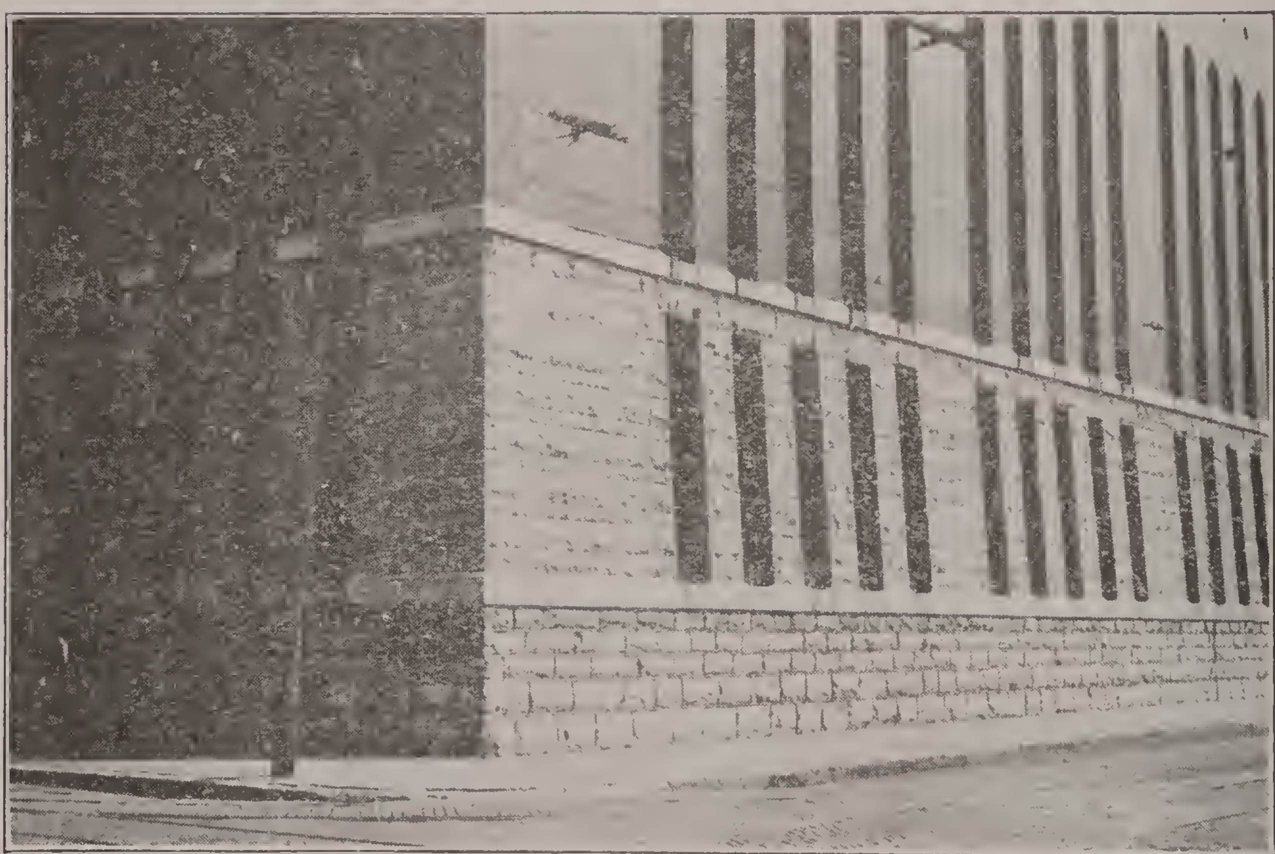
(12) *Edgar Cox Quarry.* This quarry is some 20 miles east of Louisville between Avoca and Anchorage.

(13) *Jefferson County Quarry.* This quarry is on the Brownsboro Pike, 8 miles east by southeast of the courthouse. The stone is used for macadam.

(14) *R. B. Taylor Quarry.* This quarry is some 20 miles south of Louisville, and the stone is used for macadam.

(15) *The Tucker Quarry.* This quarry is in the Laurel dolomite. The upper portion is cut into dimension blocks for building purposes, and the lower portions are used for road metal. The quarry is the largest in Jefferson County outside of the City of Louisville. It is situated at Tucker, a station on the Shelbyville-Louisville Electric Railroad.

(16) *Beargrass Quarry.* This quarry is in the eastern part of Louisville. In it can be seen the actual contact between the Jeffersonville limestone at the top and the Louisville limestone at the bottom.



51. CITY JAIL, LOUISVILLE, KY.
The lower courses represent Kentucky stone.

(17) There is an abandoned quarry near the city water works. It still carries much good building stone. It is about 3½ miles northeast of the courthouse.

(18) *Cemetery Quarry.* This quarry is a little to the northeast of Cave Hill Cemetery in a meander of Middle Fork.

(19) *Kosmos Portland Cement Co. Quarry.* This quarry is located on the Ohio River at Dugan's Landing, Ky. The relative dimensions of the quarry are: length, 1,680 feet; breadth, 900 feet; height of working face at highest point, 110 feet. The upper 36 feet is in high grade limestone, then 22 feet dolomitic limestone, then 40 feet of high grade limestone, then 5 feet of very pure limestone followed by 7 feet of impure limestone.

Jessamine County

All the terranes of Jessamine County belong to the Ordovician system. The Champlainian series covers nearly the entire county. The Cincinnatian series is represented by a narrow strip on the southeast side of Hickman Creek, and by an extremely narrow tongue extending southward from Brannon, in the northern part of the county.

The oldest exposed rocks in the State are those lying at low water on the Kentucky River at Camp Nelson in the southern part of the county, where the Kentucky River trenches the crest of the Jessamine Dome. According to Prof. A. M. Miller, the High Bridge stage of the Champlainian series is approximately 600 feet in thickness in Jessamine County, but only about 400 feet are exposed to view along the palisades of the Kentucky River.

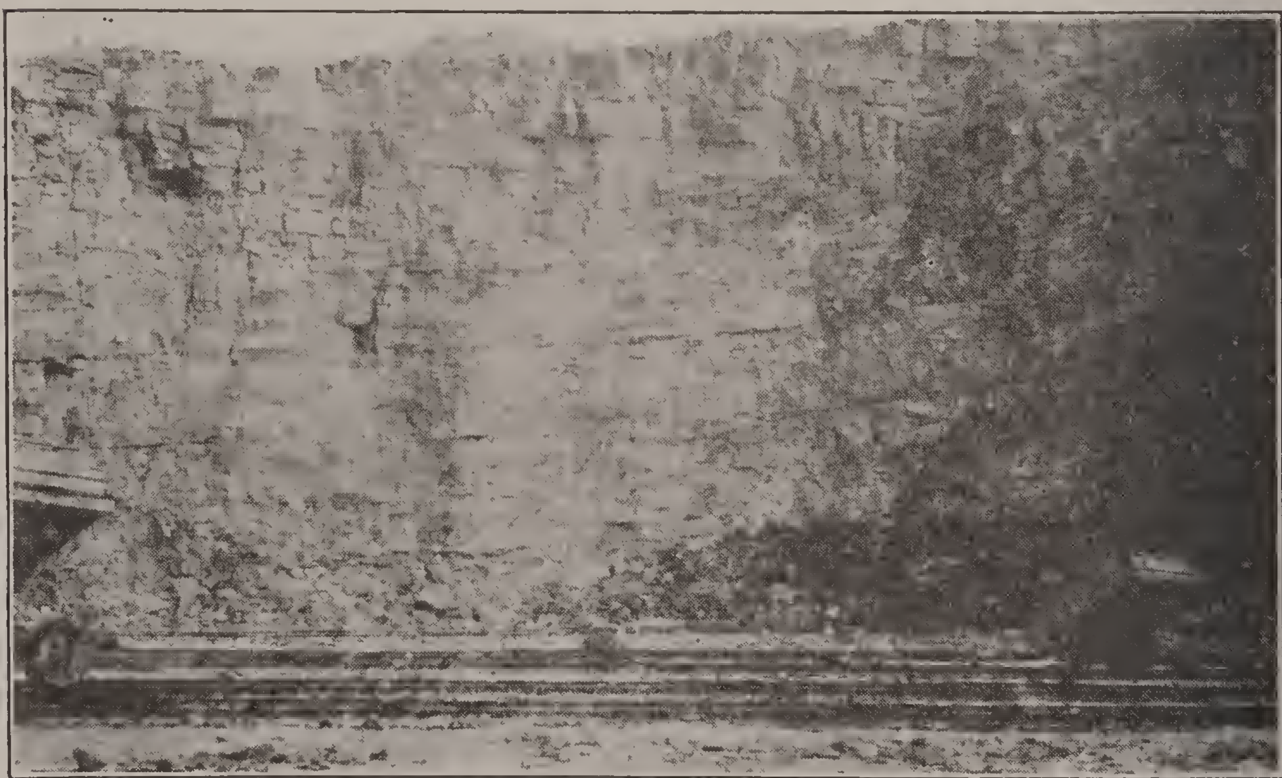
The lowest exposed member of the High Bridge stage is the Camp Nelson formation, which is 285 feet in thickness. This is a very thick bedded, massive, white to grayish white, fine grained limestone. It has a remarkable resistance to both corrosion and corrasion, and is an excellent building stone. The Camp Nelson sub-stage, showing its characteristic thick bedding, is well exposed at the Brooklyn Bridge in Woodford County.

The Camp Nelson bed is overlaid by the Oregon formation. It is the formation known in the geologic history of Kentucky as the Kentucky River Marble. It outcrops along the Kentucky River from Boonesboro to Camp Nelson whenever the river is on the northwest side of the Kentucky River fault. It is a continuous outcrop along the Kentucky River from Camp Nelson, in Jessamine County, to Clifton, in Woodford County. The thickness of the formation varies from 15 to 25 feet. It is white to buff in color, and sometimes mottled in appearance. It is a

fine grained, even textured, thick bedded, dolomitic limestone. With its magnesium carbonate content exceeding 30 per cent, it may well be classed as a dolomite. It is a very fine building stone that ought to be more widely utilized. It is well worthy of interstate reputation.

The uppermost member of the High Bridge stage of the Champlainian series is the Tyrone, with a maximum thickness of 90 feet. For a complete description of this formation see Tyrone, under Anderson County. It has been extensively quarried and used as a building stone. Its reputation should become national as a building stone.

The gray to bluish gray, granular, crystalline limestone of the Lexington stage overlies the Tyrone and furnishes stone for building purposes. It is especially well suited for foundations, abutments, bridges, culverts, railroad ballast and macadam.



52. HIGH BRIDGE QUARRY.

This quarry is at High Bridge, Jessamine County, Ky. It is in the Tyrone limestone and shows the thickness of the individual beds.

(1) *High Bridge Quarry.* This quarry is on the east side of the Kentucky River at High Bridge. The quarry is owned by the American Stone and Ballast Company of Cincinnati, Ohio. The operators and managers are Dorman and Utter. The quarry has been in continuous operation for over

20 years. The quarry face does not mark a straight line. Its circuitous length is 1,200 feet. Its breadth is 750 feet. Its height as measured by an aneroid barometer is 62 feet. It is one of the largest quarries in the State. The individual beds are from 2 to 4 feet in thickness, and contain much valuable building stone.

There is at this quarry a very large rock crusher which makes a larger variety of crushed stone than most crushers throughout the State. No. 1 is 4 inches in diameter, No. 2 is 3 inches in diameter, No. 3 is 2 inches in diameter, No. 4 is 1 inch in diameter, and No. 5 is screenings and dust.

(2) This is a small quarry on the right of High Bridge.

(3) This is a small quarry on the left of High Bridge. The stone removed from both has only been used locally.

53. WILMORE QUARRY, WILMORE, KY.

This quarry is near Wilmore, Jessamine County, Ky. It shows the thickness of the individual beds.

High Bridge, a quiet little village on the bank of the Kentucky River, should not be confused with the high bridge over the Kentucky River at this point. The bridge known as High Bridge is 1,230 feet in length and 308 feet above the Kentucky River at normal level. It is said to be the highest structure of its kind over a navigable river in the United States.

(4) *Glass Mill Quarry.* This quarry is situated between Wilmore and Glassmore. The stone for the new Catholic Church in Nicholasville, the county seat, came from this quarry. The beds are from 2 to 4 feet in thickness, and the product is a good building stone. The William B. Glass Company's warehouses at Wilmore, and the stone for the foundation of the new High School at Wilmore, came from this quarry.

(5) *Davis and Delong Quarry.* This quarry is on a branch road from the main road from Wilmore to High Bridge. The quarry is several hundred feet in length, and quarried at 3 different openings. The quarry face is from 10 to 15 feet in height. The beds are thick, and the stone is good.

(6) *Camp Nelson Quarry.* This quarry is at Camp Nelson on the north bank of the Kentucky River. It furnished the stone used in a large number of distilleries along the Kentucky

54. WILLIAM B. GLASS COMPANY WAREHOUSE.
This warehouse is at Wilmore, Jessamine County, Ky. It was built of stone from the Glass Quarry.

River. These walls in many cases illustrate well the value of the stone in constructional work.

(7) *Rev. D. W. Alexander Quarry.* This quarry is situated 6 miles east of Nicholasville. It furnished the stone for the foundation of the courthouse at Nicholasville.

Kenton County

The terranes of Kenton County all belong to the Ordovician system. The Champlainian series, Cynthiana, is represented in a narrow strip along the west side of the Licking River. The remainder of the rocks belong to the Cincinnatian series. The Cynthiana formation is flanked on the northwest by the Eden shales, which in turn are flanked by the Maysville and Richmond formations.

The limestones of Kenton County are thin bedded. They are of gray to bluish gray color, and some foundations in Covington constructed from them are fairly pleasing in their effect. The foundations, retaining walls and decorative walls often show shaly layers or partings that produce a somewhat laminated effect.

55. PAROCHIAL SCHOOL, COVINGTON, KY.

The foundation of this school building, Covington, Kenton County, Ky., is limestone from Kenton County.

(1) *City Quarry.* This quarry is situated on the Altamont road, 2 miles southwest of Covington, the county seat. The quarry is 800 feet in length, 100 feet in breadth, and the height of the working face is 35 feet. The thickest bed of limestone in this quarry is 12 inches. The stone is used for foundation work, abutments, bridges, culverts, curbing and road construction.

(2) *Scholler Quarry.* This quarry is on Highland Pike, 3 miles southwest of Covington. The length of the quarry is approximately 900 feet, the breadth is 150 feet, and the height 40 feet. The stone is used for the same purposes as No. 1. The foundations of the Parochial School building between Washington and Russell Streets came from this quarry.

(3) This quarry is located about 3 miles south of Covington on the Lexington Pike. It is now inactive, but it is operated intermittently for purposes of road construction.

The First National Bank in Covington was erected with Rockcastle County freestone in 1905, and no block in the entire structure showed any discoloration from iron.

Lincoln County

The terranes of Linclon County belong to the Ordovician, Silurian, Devonian and Mississippian systems. The Cincinnatian series of the Ordovician covers the whole of the northern part of the county. These are limestones. The Silurian outcrops in the vicinity of Crab Orchard. The area of outcrop extends eastward from Crab Orchard to Rockcastle County and westward to a point a few miles west of Maywood, on the Southern Railroad System. There are also a few inliers of the Silurian in the Ordovician area, especially to the northwest of Crab Orchard. The Silurian is wanting in the western part of the county. A narrow belt of the Devonian shale passes east and west across the county, and the whole of the southern portion of the county is covered with the Mississippian formation.

(1) *Stanford Quarry.* This quarry is situated near Stanford, the county seat. The stone has been used locally for foundation work in Stanford, and for road construction.

(2) *Knob Lick Quarry.* This quarry is located near Knob Lick, and the stone is used for road work.

Two miles east of Crab Orchard there is a limestone or marble ledge, well crystallized, 14 feet in thickness at exposure, that would take a very high polish and make a beautiful stone for both massive construction and decorative interior work. There is also near Gilberts Creek a pink marble traversed by dark zigzag bands closely resembling the pink Tennessee marble. This rock is fine grained, well crystallized, and good for both building and monumental work.

Madison County

The terranes of Madison County are widely varied in age. They belong to the Ordovician, Silurian, Devonian, Mississippian and Pennsylvanian systems.

The Champlainian series of the Ordovician is represented only by a narrow belt of outcrops along the Kentucky River in the northern and northwestern part of the county, and also in the northwestern part along the tributaries to the Kentucky River from the south. These lower formations contain excellent building stone.

The Cincinnatian series of the Ordovician occupies more area in this county than all other formations combined. The western portion is covered by the Eden shales, which are too thin bedded and friable for building stone. The central portion is covered by the Maysville and Richmond formations, which occasionally carry beds of limestone sufficiently massive and thick bedded for building purposes.

The Silurian formations traverse the eastern part of the county, and pass in a southwesterly direction across it, a little south of Paint Lick. The Devonian shales stretch across the entire southwestern part of the county. The Mississippian formation occupies the southern portion, with some tongues of the Pennsylvanian extending out into the Mississippian.

The rocks in the southern and western half of the county are thin bedded and shaly, and from them no building stones can be expected, with the exception of one area of freestone noted later. The Maysville and Richmond formations in the central part have furnished some stone for local use around Richmond, the county seat. The High Bridge along the Kentucky River can furnish much building stone, but only one quarry has been operated extensively in this group of formations.

(1) *Ford Quarry.* This quarry is near Ford, a small station on the Louisville & Nashville Railroad, about 10 miles north of Richmond. It has furnished both building stone and road stone.

(2) *City Quarry.* This is a small quarry near Richmond that has furnished a little stone for foundations, curbing, etc., in Richmond. It weathers gray, but uniformly.

(3) *Berea Quarry.* A quarry was reported to the south of Berea, and a little to the east of the Louisville & Nashville Railroad, that furnished the sandstone for several buildings at Berea College. Also for abutments, bridges, culverts, curbing, etc.

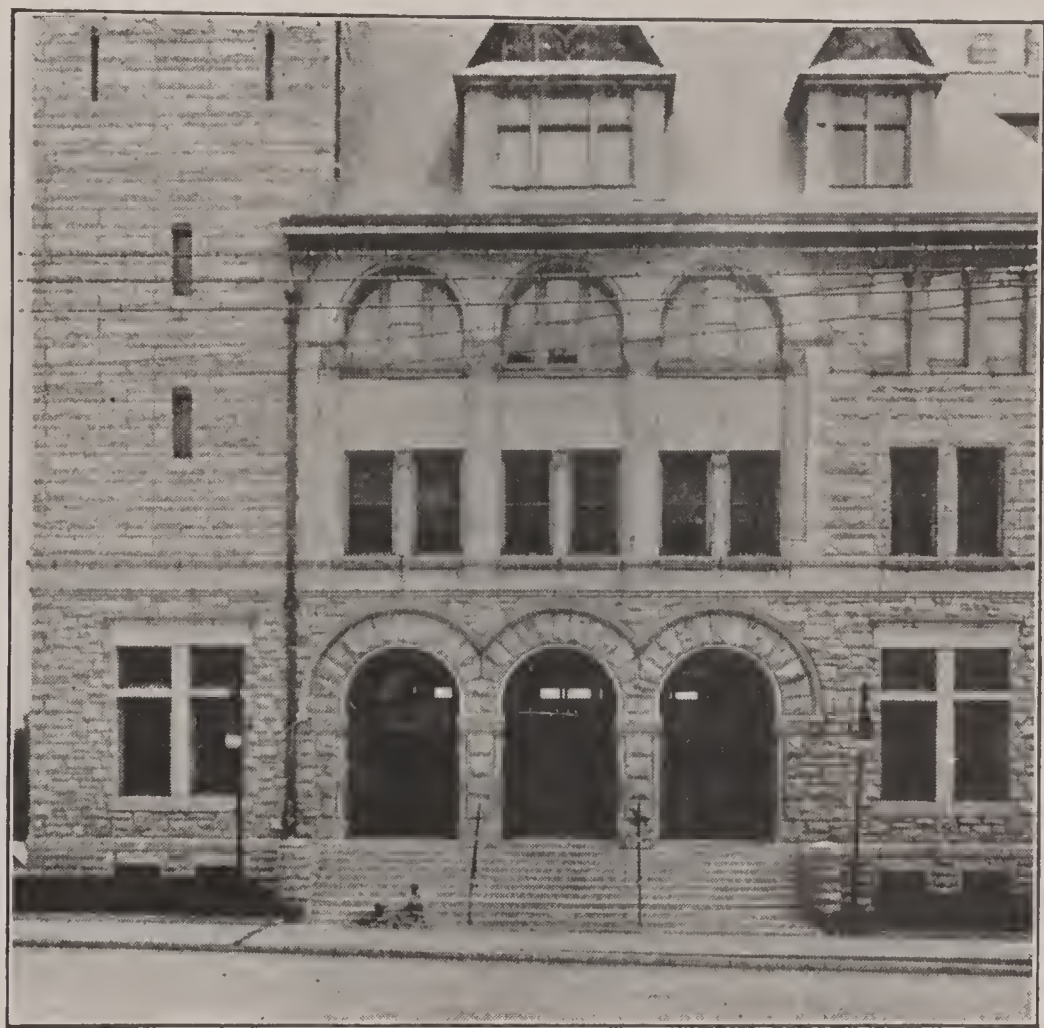
56. CITY QUARRY, RICHMOND, KY.
This quarry is in massive, dark gray limestone near Richmond, Madison County, Ky.

(4) *County Quarry.* This quarry is used entirely in the construction of permanent roads.

The post-office at Richmond was erected under an Act of Congress introduced by Hon. James B. McCreary, and approved February 24, 1891. The stone for this post-office came from the Langford quarry at Langford in Rockcastle County. This building is remarkably well preserved, and very pleasing in its architectural effect. It testifies to the value of Kentucky freestone for building purposes.

The base of the Christian Church came from the Tyrone formation from the Marble Creek quarry in Jessamine County. Rockcastle County freestone was used in the decorations. The St. Marks Catholic Church on Main Street was erected with Tyrone stone from the Marble Creek quarry. The State Bank and Trust Company Building contains Rockcastle County freestone from one of the small quarries near the Langford quarry. The stone in the McKee Building on Main and First Streets came from the same quarry as that in the State Bank and Trust Company Building.

The slate underneath the Knobs in the eastern and southeastern part of the county has been used to quite an extent in surfacing the highways.



57. POSTOFFICE, RICHMOND, KY.
This Government Building at Richmond, Madison County, Ky., was built of Rockcastle County freestone and shows well the value of this stone for massive construction.

Marion County

The terranes of Marion County fall into the Ordovician, Silurian, Devonian and Mississippian systems. The Cincinnatian series is by far the most important commercially. These outcrops cover the entire northern half of the county, save a rather small area in the northwestern part, bordering Nelson County. The Eden shales of the Cincinnatian series outcrop in the extreme northeastern part of the county. The Maysville outcrops occupy the northern portions, and it is in this formation that the building stones are obtained.

The Silurian system is represented only on the northwestern part of the county. From the western border of Marion County to the eastern part of Lincoln County the Silurian for-

mations are virtually wanting, and therefore the Devonian shales flank the Ordovician limestones on the south. The extreme southern portion is entirely Mississippian in age.

The Silurian, Devonian and Mississippian are all too thin bedded and too shaly to produce building stones. The Maysville formation of the Cincinnatian series furnishes some excellent building stones. These vary in color from a light or cream gray to a bluish gray. In texture, they vary from fine grained to coarse grained. Some of the calcite crystals exceed ½ inch in diameter, and both the larger and the smaller crystals show perfect rhombohedral cleavage. The stone is so completely recrystallized that it takes a good polish, and a polished sample can be seen as No. 69a in the museum of the Kentucky Geological Survey. It is classified as one of the Kentucky marbles. The stone weathers white, and is well suited for massive constructional work, as well as decorative interior work. Dark zigzag bands occasionally traverse the stone.

58. ESTES QUARRY, LEBANON, KY.
This quarry is near Lebanon, Marion County, Ky. It shows the thickness of the individual beds of white building stone.

(1) *Chicago Quarry.* This quarry is situated near Chicago, a small station on the Louisville & Nashville Railroad, about 10 miles west by northwest of Lebanon, the county seat of Marion County. The quarry is in thin bedded limestone, and the product is used entirely in road construction.

(2) *T. M. Estes Quarry.* This quarry is located within the city limits of Lebanon, a little north of the courthouse. The stone has been used quite extensively for building purposes. It is very good.

(3) *T. M. Estes Quarry.* This quarry is located on the Springfield Pike, 1 mile north of the courthouse. It contains both the light gray and the bluish gray, well crystallized varieties of limestone. The individual beds are from 2 to 4 feet in thickness. The rock is an excellent building stone. The large blocks should be sawed, and care taken to reject all blocks that show evidence of dead seams, for in some of these dead planes a little iron sulphide occurs.

(4) *Stephen Rogers Quarry.* This quarry is on the Bradfordsville Pike, 4 miles southeast of Lebanon. The stone is used in road construction.

(5, 6, 7, 8, 9) These quarries are all on the Danville Pike, within 6 miles of Lebanon. The first is almost 2 miles west, and the others about 1 mile apart. The stone is used for foundations and macadam.

(10) *St. Mary Quarry.* This quarry is situated at St. Mary, a small station on the Louisville & Nashville Railroad, about 3 miles west of Lebanon. The stone is an excellent building stone that weathers white and is very pleasing in its effect. The St. Mary's Church was built of this stone, from an abandoned but not exhausted quarry near the church. The stone was also used in foundations and approaches to the Loretto School for girls.

(11) *Humphrey Quarry.* This quarry is on the Springfield Pike, 4 miles north of Lebanon. It is a good building and road stone.

(12) *Jackson Lane Quarry.* This quarry is situated 2 miles south of the courthouse. The stone is thin bedded, and is used in road construction.

(13) *Miller Pike Quarry.* This quarry is on Miller Pike, 3 miles southwest of Lebanon. The stone is used for macadam.

(14) *Jimtown Quarry.* This quarry is within the city limits, and near the Campbellsville Pike.

(15) *Rains Hill Quarry.* This quarry is also within the city limits. Both Nos. 14 and 15 are small quarries.

(16) *Loretto Quarry.* This quarry is at Loretto. It furnished the base course for Loretto Academy. The stone was quarried for this purpose over 30 years ago. The stone is of light gray color, weathers white, and is pleasing in its effect. It is a very good building stone.

Mason County

Practically all the terranes of Mason County belong to the Cincinnatian series of the Ordovician system. There is supposed to be one small area of Silurian outcrops in the extreme eastern part of the county. This has no commercial significance. The Eden shales occupy the western and northern portions of the county. The Maysville formation covers the whole southeastern portion with a somewhat narrower belt, stretching in a northwesterly direction across the entire county.

Practically all the limestones are thin bedded and intercallated more or less with shaly layers. In color they are blue, bluish gray, gray, and dark gray. They are fine to medium grained in texture. They are massive, hard, and resistent to the corrosive agents of the atmosphere. Some of them are sufficiently recrystallized to be classified as marbles. They are susceptible of a high polish, and the contrast is marked between the dark polished surface and the white hammered face. The marble is well adapted to decorative interior work. For panelling and inlaid floors it is especially well suited. With a judicious selection of this dimension stone, it would prove satisfactory for building purposes.

In the early history of the county a number of stone houses were erected. The stone has stood the test of time well. Some blocks that should have been rejected by the builders found their way into some of these structures, as they have in other localities into almost all early stone structures. These stone dwellings were erected in Maysville, Mayslick, Washington, and elsewhere in Mason County. The foundation of the Maysville High School is of local stone, also the base course of First Methodist Episcopal Church, South.

The 35 quarries listed below are all in limestone. Each quarry carries much the same quality of stone. The upper beds in the various quarries are the lighter gray, and the lower beds

the darker gray. Quarry No. 7 has the best building stone of any quarry in the county. The individual beds here are from 2 to 3 feet in thickness. The thickest beds are towards the bottom of the quarry. The lowest beds are well crystallized.

(1) *L. Anderson Quarry.* This quarry is just outside the city limits to the west of Maysville, the county seat.

(2) *W. Wadsworth Quarry.* This quarry is also just outside the city limits to the west of the courthouse.

(3) This is a private quarry on the Lexington Pike, 2 miles southwest of Maysville.

(4) *Thomas Malone Quarry.* This quarry is on the Lexington Pike, 4½ miles southwest of Maysville.

(5) *County Quarry.* This quarry is on the Lexington Pike, 6 miles southwest of the courthouse.

(6) *County Quarry.* This quarry is on the Lexington Pike, 9 miles southwest of Maysville.

(7) This quarry is on the Mayslick Pike, 12 miles southwest of the courthouse.

(8) *County Quarry.* This quarry is 1½ miles southeast of Maysville.

(9) *S. M. King Quarry.* This quarry is 2 miles southeast of the courthouse.

(10) *County Quarry.* This quarry is 7 miles southeast of Maysville.

(11) *County Quarry.* This quarry is at Marshall Station, 8 miles southeast of Maysville.

(12) *County Quarry.* This quarry is 11 miles southeast of Maysville.

(13) *County Quarry.* This quarry is on Mill Creek, 12½ miles southeast of Maysville.

(14) *County Quarry.* This quarry is 17 miles southwest of Maysville.

(15) *Private Quarry.* This quarry is 15 miles southwest of Maysville.

(16) *H. C. Hawkins Quarry.* This quarry is at Mayslick, 12 miles south of Maysville. It contains very good building stone.

(17) *Private Quarry.* This quarry is 17 miles southwest of Maysville.

(18) *John Hunter Quarry.* This quarry is on the Murphysville Pike, 5 miles southwest of the courthouse.

(19) *Thomas Rhodes Quarry.* This quarry is on the Murphysville Pike, 7 miles southwest of Maysville.

(20) *John Latham Quarry.* This quarry is on the Sardis Pike, 10 miles southwest of Maysville.

(21) *County Quarry.* This quarry is on the Murphysville Pike, 12 miles southwest of Maysville.

(22) *County Quarry.* This quarry is 16 miles southwest of Maysville, and 1 mile from Sardis.

(23) *Sardis Quarry.* This quarry is between No. 22 and the village of Sardis.

(24) *Private Quarry.* This quarry is about 1 mile from Sardis.

(25) *County Quarry.* This quarry is on Clarks Run, 5 miles southwest of Maysville.

(26) *John Simmon Quarry.* This quarry is 10 miles west of the courthouse.

(27) *County Quarry.* This quarry is on the Germantown Pike, 2 miles west of Maysville. It contains very good building stone.

(28) *County Quarry.* This quarry is 7 miles west of Maysville.

(29) *Ed. Dyar Quarry.* This quarry is 11 miles west of Maysville.

(30) *Frank Boyd Quarry.* This quarry is 12 miles west of Maysville at Minerva. The stone is very good for building.

(31) *R. O. Stewart Quarry.* This quarry is 10 miles west of the courthouse.

(32) *Private Quarry.* This quarry is 12 miles west of the courthouse on the Fern Leaf and Dover Pike.

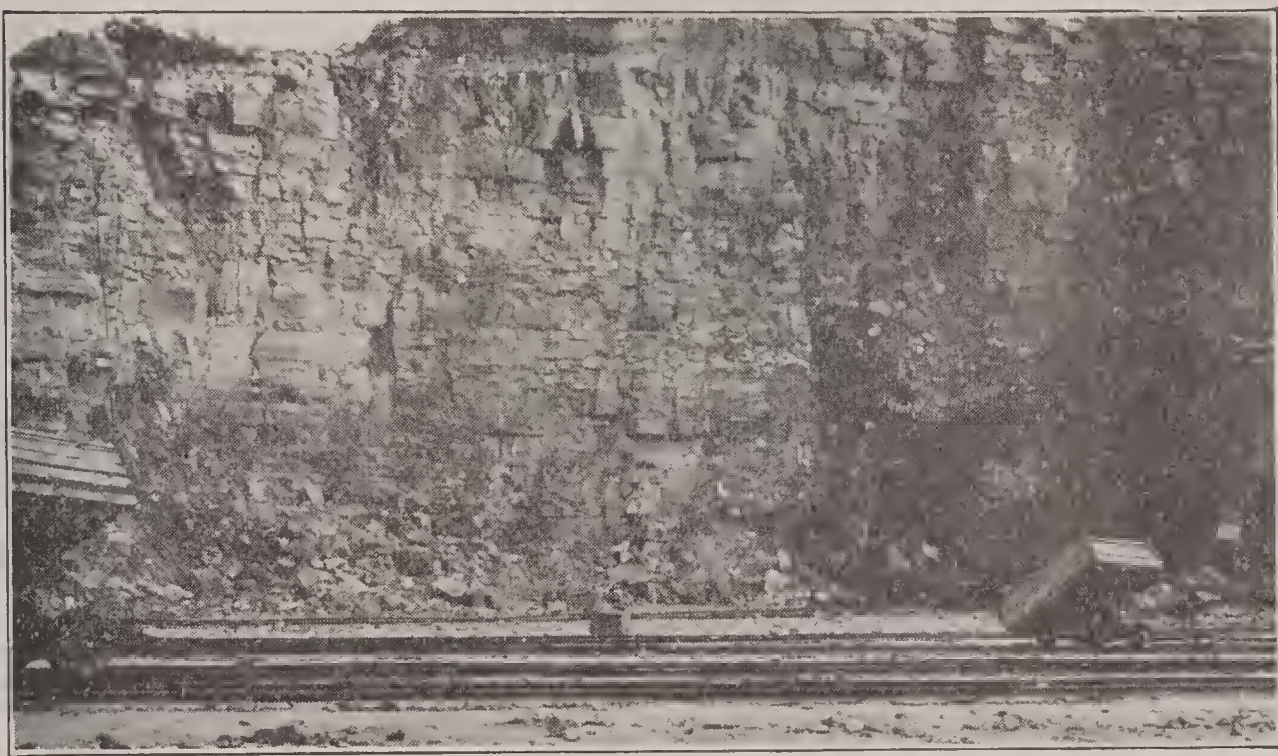
(33) *County Quarry.* This quarry is on the Minerva and Tuckahoe Pike, 6 miles west of Maysville.

(34) *County Quarry.* This quarry is on the Hill City Pike, 6 miles south of Maysville.

(35) *County Quarry.* This quarry is 5 miles south of Maysville, on the Hill City Pike.

MERCER COUNTY

The terrancs of Mercer County belong to the Ordovician system. Nearly all of them are in the Champlainian series. The High Bridge stage, Camp Nelson, Oregon and Tyrone formations, forms the high bluffs along the Kentucky River on the eastern boundary of the county. In scaling the bluffs from the Kentucky River to Shakertown, over 300 feet of rock is exposed. Aside from the narrow Kentucky River belt, the eastern half of the county is covered by the Lexington stage, and the western half chiefly by the Cynthiana formation. The Eden shales of the Cincinnatian series cover a somewhat limited portion of the western half. These shales are the youngest rocks represented within the county.



59. TYRONE QUARRY.
This quarry is at Tyrone, Mercer County, Ky. The quarry is in the Tyrone limestone.

The Oregon bed, Kentucky River marble, and the Tyrone bed, Kentucky marble, produce two of the finest building stones of the State. The supply along the Kentucky River is inexhaustible. The Tyrone formation was quarried many years ago for the beauitful stone structures at Shakertown. The gray, granular, crystalline Lexington formation furnishes a good building stone. A little northwest of Harrodsburg along the Harrodsburg-Cornishville Pike, the Lexington limestone is coarse grained, heavy bedded, and well crystallized.

(1) *Shakertown Quarry.* This abandoned quarry was in the Tyrone formation under the bluffs of the Kentucky River. It furnished the stone for numerous buildings in Shakertown. There has been so much work done in constructing the road from Shaker Ferry to Shakertown that the exact location of the quarry was not made. The limestones of this bluff in Mercer County can furnish an inexhaustible supply of good building stone.

(2) *Harrodsburg Quarry.* This quarry is situated within the city limits of Harrodsburg, the county seat of Mercer County. It has furnished a considerable amount of building stone for use in Harrodsburg. The stone is of bluish gray color and weathers nearly white. It belongs to the Lexington formation. In 1882 Mr. Wagner cut and polished a monument that received a very high polish, from the Harrodsburg marble.

(3) This quarry is just outside the little hamlet of Shakertown, on the Shakertown-Danville Pike.

(4) This quarry is also on the Shakertown-Danville Pike about 2 miles from Shakertown.

(5) *Burgin Quarry.* This quarry is near the little village of Burgin, 2 miles southeast of Harrodsburg. The stone is used for macadam.

(6) This quarry is about 1 mile northwest of Harrodsburg on the Cornishville Pike. The stone is well suited for building purposes.

Montgomery County

The terranes of Montgomery County belong to the Ordovician, Silurian, Devonian, Mississippian and Pennsylvanian systems. All of the Ordovician rocks are Cincinnatian in age. The thin bedded Eden shales cover the northwestern part of the county. The Maysville and Richmond stages of the Cincinnatian series traverse the entire county in a northeasterly direction. Mt. Sterling, the county seat, is in this group. The Richmond beds are flanked on the southeast by the Silurian formations. These are flanked on the southeast by the Mississippian terranes. There are a few outcrops of the Pennsylvanian forming the crests of the Knobs. Therefore, the oldest rocks are in the northwestern part of the county, and the youngest on the crests of the Knobs in the southeastern part.

The limestones of Montgomery County are as a rule thin bedded, and more or less intercalated with shale. The shale disintegrates rapidly, and leaves in numerous cuts and exposures the more resistant limestones protruding from the retreating shale. The limestones are gray, bluish gray, and dark gray in color. They are fine grained and even textured. Some of them are well recrystallized and susceptible of good polish. These more highly crystallized members are well suited for decorative interior work. They hammer white, and the contrast is strong between the white hammered faces and the dark gray polished surface. These limestones have been used for foundations, trimmings, abutments, bridges, culverts, curbing, paving, railroad ballast and macadam.

In spite of the fact that Montgomery County has 25 quarries listed below, Rowan County has been a large contributor to the supply of stone for constructional work in this county. Building stone has been used in Mt. Sterling from Farmer, Freestone and Bluestone. The base of the courthouse, the Tyler-Apperson block, the Baum block, and the Martin building all carry Rowan County freestone. This stone in large dimensions has been used in many of the sidewalks of Mt. Sterling.

(1) *De Bard Quarry.* This quarry is situated on the Winchester Pike, one-half mile west of Mt. Sterling.

(2) *Kelly Quarry.* This quarry is on the Winchester Pike, 2 miles west of Mt. Sterling.

(3) *Steagall Quarry.* This quarry is on the Levee Pike, 1 mile from Mt. Sterling.

(4) *Winn Quarry.* This quarry is on the Hinkston Pike, 1 mile from Mt. Sterling. Both the gray and blue varieties are present. The dark gray bed receives a good polish, and is a good building stone. The best beds are at the bottom of the quarry. This quarry is now owned and operated by J. W. Richards. The quarry is 300 feet in length, 200 feet in depth, and with a working face 30 feet in height. It could be easily worked 10 feet deeper. The crusher at this quarry has a 100-ton capacity. The better stone is here worked into dimension blocks, and used for building purposes.

(5) *Grassy Lick Quarry.* This quarry is on the Grassy Lick Pike, 2½ miles west of Mt. Sterling. It was inactive.

(6) *Thompson Quarry.* This quarry is on the Maysville Pike, 3 miles north of Mt. Sterling. Both the gray and blue limestones occur at this quarry.

(7) *Clarence White Quarry.* This quarry is on the Maysville Pike, 4 miles north of Mt. Sterling.

(8) *Peter Kelley Quarry.* This quarry is on the Maysville Pike, 1½ miles north of Mt. Sterling. Both the blue and gray varieties are present. It is a very good quarry.

(9) *Camargo Quarry.* This quarry is on the Camargo Pike, 1½ miles from Mt. Sterling. This quarry was represented to have furnished considerable foundation stone.

(10) *Mitchell Quarry.* This quarry is on the Winchester Pike, one-fourth mile west of Mt. Sterling.

(11) *Moberly Quarry.* This quarry is on the Paris Pike, 3½ miles northwest of Mt. Sterling.

(12) *Johnson Quarry.* This quarry is on the Paris Pike, 3 miles northwest of Mt. Sterling.

(13) *Wren Quarry.* This quarry is on the Van Thompson Pike, 7 miles northeast of Mt. Sterling.

(14) *City Quarry.* This quarry is on the Spencer Pike, 6 miles east of Mt. Sterling. The quarry is in a buff and yellowish sandstone. The individual beds range from 18 inches to 3 feet in thickness. The stone is used for abutments, bridges, foundations, etc. The columns for the Christian Church at Spencer came from this quarry.

(15) *Bryson Quarry.* This quarry is on the Maysville Pike, 7 miles north of Mt. Sterling.

(16) *James White Quarry.* This quarry is on the Maysville Pike, 4½ miles north of Mt. Sterling.

(17) *Gatewood Quarry.* This quarry is on the Step Stone Pike, 3 miles east of Mt. Sterling.

(18) *Turley Quarry.* This quarry is on the Levee Pike, 1½ miles south of Mt. Sterling.

(19) *Anderson Quarry.* This quarry is on the Levee Pike, 3½ miles south of Mt. Sterling.

(20) *Tremble Quarry.* This quarry is on the Camargo Pike, 5 miles south of Mt. Sterling.

(21) *Hastie Quarry.* This quarry is on the Judy and Flat Rock Pike, 7 miles northwest of Mt. Sterling. The stone is very good for building purposes.

(22) *W. F. Henry Quarry.* This quarry is on the Judy and Flat Rock Pike, 7½ miles northwest of Mt. Sterling. It contains good building stone.

(23) *W. F. Henry Quarry.* This quarry is on the Side View and Aaron River Pike, 8 miles northwest of Mt. Sterling. The quarry has a working face 20 feet in height.

(24) *Flanders Quarry.* This quarry is on the Judy and Flat Rock Pike, 8½ miles northwest of Mt. Sterling.

(25) *Davis Reed Quarry.* This quarry is on the Winchester Pike, 3 miles west of Mt. Sterling.

Pilot Knob. There is an outcrop of Pottsville Conglomerate on Pilot Knob that is worthy of more than passing mention. Pilot Knob is located about 9 miles south of Mt. Sterling, Montgomery County. A part of the Knob is in Montgomery and a part is in Powell County.

It is furthermore said to be within 2½ miles of the Louisville & Nashville Railroad, from which a spur may be easily extended to the base of the Knob. The conglomerate itself occupies a somewhat semi-circular ridge, with an axis in a northeasterly direction. This outcrop is more than one-half mile in length, and would doubtless average 200 feet in width. This average cannot be ascertained at the surface for the crest of the ridge is very narrow. The study of the gravel from which the cement holding the pebbles together has been dissolved out leads to the conclusion that the loose, incoherent gravel is comparatively shallow, and that the true conglomerate or cemented gravel lies buried beneath it. The depth of the gravel, or conglomerate, is in places definitely proven to be 75 feet in thickness, and may be 100 feet in thickness. On the right hand side of the central knob is one of the best places to ascertain the thickness, but even here there is no proof positive that decomposition has been extended to the bottom of the conglomerate. It would require development work to ascertain its actual thickness. At present no development work has been executed upon this property.

An excellent place to open up a quarry is between the shelf of rock at the south end of the central knob and the north end of the knob at whose base there is a fine spring. The amount of gravel that can be removed at this point without blasting is unknown, because no excavations have been made in the material. Furthermore, this point is desirable for opening a quarry because the overburden of compact sandstone is here reduced to a minimum. Therefore, there is practically no waste to be discharged into the large valley to the north.

This overburden when actually encountered may be itself with the few pebbles that are scattered through it an excellent railroad ballast, or road building rock; and the author would suggest that when perfectly fresh and undecomposed rocks are quarried, that a forty-pound sample, preferably in four pieces, be sent to Prof. D. V. Terrell, University of Kentucky, Lexington, Kentucky, for analysis as to its value in road construction. This value cannot be determined without a fresh rock upon which to make the test.

The conglomerate itself with pebbles varying in size from a small pea to that of a hen's egg is in the author's judgment an ideal railroad ballast. While that may hold true of the gravel that has already been worked into incoherent pebbles by the prolonged action of the atmosphere, it does not prove that the fresh and unweathered portions that will be encountered in the quarry work will be of equal value. Neither can the character of the conglomerate, that is, the ease with which the conglomerate will break down into pebbles, be determined until a quarry has been opened as suggested, and the material broken up ready for shipment by railroad. In blasting the material, difficulties will be encountered in drilling superior to those met with in drilling limestone, for the hardness of each quartz pebble, and this is practically the only pebble in the gravel, is seven in the scale of hardness; while the hardness of calcite crystals in the crystalline limestone is only three.

The cement binding these pebbles together is largely the oxides and hydrous oxides of iron. There is some clayey matter in the cement at the surface exposures, but the amount is small. The conglomerate varies somewhat in the coarseness of the pebbles. There will be encountered from time to time in the

process of work sands that are fine enough and pure enough for the manufacture of high grade cements; the value of such sand is superior to the value of the conglomerate used direct for railroad ballast. The tonnage of the entire product based upon measurements made, extends into the millions, and with an output of five hundred tons a day or a carload per day of fifteen cars for three hundred working days in the year, it would require more than a century to remove all of the gravel resulting from the decomposition of this conglomerate, and the conglomerate itself. Therefore, a rational conclusion is that the supply is practically inexhaustible.

The author would call attention to the fact that there is in Brazil, South America, a conglomerate in which the pebbles are about the same size as the pebbles in this conglomerate; and the undecomposed product with an iron cement similar to the one in the Pilot Knob conglomerate renders the whole susceptible of a very beautiful polish, and therefore well suited for expensive grades of decorative interior building stone. The massiveness of this knob, together with the character of some samples secured where the cement is pronouncedly iron, suggests this possibility.

Nelson County

The terranes of Nelson County are Ordovician, Silurian, Deconian and Mississippian in age. The Ordovician system, Cincinnatian series, covers the entire northern part of the county. The Eden shales of the Cincinnatian series outcrop only in the extreme northeast part of the county. The remainder of the northern part is covered by the Maysville and Richmond formations. These formations are flanked on the south and west by the Silurian system, Niagaran series, which are in turn flanked in the same manner by the Devonian shales. The Mississippian outcrops are limited to a very narrow belt in the southern part, together with a few small inliers.

The building stones of Nelson County are mostly limestones and marbles. They are white or grayish white, gray, bluish gray and mottled. Some of them are traversed by dark zigzag bands. Some are well crystallized and susceptible of a polish.

One suggests when polished a Circassian Walnut color that is very pleasing in its effect. The individual layers are usually thicker bedded than they are in the eastern counties in the Bluegrass region.

60. RESIDENCE OF THOMAS S. MOORE, BARDSTOWN, KY.

This residence at Bardstown, Nelson County, Ky., shows the architectural effect of both stone and brick in the same structure. The stone in part came from the ledges near the house and in part from the distillery quarry.

Most of the building stone used in Bardstown came from local quarries in Nelson County. The Thomas S. Moore dwelling came in part from stone quarried by the house and in part from a quarry about one-fourth mile distant. The county jail was erected of stone from the old quarry near the Tom Ward distillery. The body of the station at Bardstown is local limestone, weathering gray to buff. The hotel, 116 years old, was built of stone from near the Tom Ward distillery. The railroad station at Nazareth, a small station on the Louisville & Nashville Railroad, was built of local stone. It weathers buff. The stone

in the Baptist Church in Bardstown came from the quarry at Quarry Switch in Bullitt County, 12 miles north of Bardstown.

(1) *City Quarry.* This quarry is within the city limits of Bardstown, the county seat, on the east side of the courthouse. The length of the quarry is 300 feet, the breadth is 100 feet, and the height of the working face is 12 feet. The top rock, 2 to 3 feet, is a variegated sandstone that is used quite extensively in retaining walls. The remaining 9 to 10 feet is in gray limestone, and the solid quarry floor is in hard, dark blue limestone. This quarry contains good building stone.

61. COUNTY JAIL, BARDSTOWN, KY.

This jail at Bardstown, Nelson County, Ky., was built of limestone from the distillery quarry many years ago.

(2) *Jenkins Quarry.* This quarry is on the Bardstown Pike, 3½ miles north of the courthouse. It is 200 feet in length, 50 feet in breadth, and the height of the working face is 13 feet. It is in a very hard, bluish gray limestone. There is a crusher at this plant with 100-ton capacity. The product is a most excellent road stone.

(3) This quarry is also on the Bardstown Pike, a little further north than No. 2. The hard blue limestone beds here are from 18 inches to 2 feet in thickness, while the gray limestone beds range from 3 to 8 feet in thickness. It contains good building stone, but has been inactive since 1911.

(4) *County Quarry.* This quarry is on the Elizabethtown Pike, 1 mile west of the courthouse. The quarry is 200 feet in length, 75 feet in breadth, and the height of the working face is 12 feet. There is one bed 6 feet in thickness that is a fine building stone. There is a banded layer 2 feet in thickness and a blue layer at the bottom 5 feet in thickness.

(5) This is a private quarry on the Elizabethtown Pike, 7 miles west of Bardstown. There is about 5 feet of bluff sandstone at the top of the quarry, and 10 feet of white limestone beneath the sandstone. This quarry carries good building stone, especially in the thicker bedded white limestone.

(6) *County Quarry.* This quarry is on the Elizabethtown Pike, 5 miles west of the courthouse. The quarry is 75 feet in length, 50 feet in breadth, and the height of the working face is only 8 feet. All the beds are white or faintly grayish white in color, massive, fine grained and even textured. It is regarded by the author as the best building stone, the best road stone, and the best agricultural stone in the county. This rock was reported to contain over 99 per cent of calcium carbonate.

(7) *Dr. Wright Quarry.* This quarry is situated on the Bardstown and Fairfield Pike, 8½ miles northeast of the courthouse. The individual beds range from 5 to 7 feet in thickness. It is in the hard blue limestone, which is an excellent road stone.

(8) *County Quarry.* This quarry is near Woodlawn, 6 miles east of Bardstown. The quarry is 60 feet in length, 30 feet in breadth, and 8 feet in height of working face. The individual beds are from 1 to 2 feet in thickness, gray in color, and compact. It is a good building stone.

(9) *County Quarry.* This quarry is on the Springfield Pike, 5 miles southeast of the courthouse. The quarry is 100 feet in length, 50 feet in breadth, and with a height of working face 8 feet. It is in very massive blue limestone.

(10) *County Quarry.* This quarry is 11 miles south of Bardstown, near the small station of New Haven on the Louisville & Nashville Railroad. This quarry is 40 feet in length, 20 feet in breadth, and 5 feet in height of working face. The quarry is in the gray limestone. The floor of the quarry is solid limestone, and the quarry can be advantageously worked to a greater depth.

(11) *New Hope Quarry.* This quarry is one-half mile north of New Hope. It is owned and operated by Thomas Miller. The quarry is 50 feet in length, 30 feet in breadth, and the height of working face is 14 feet. It is in the gray limestone, with individual beds ranging from 2 to 3 feet in thickness. It is a good building stone.

(12) *County Quarry.* This quarry is located 1 mile north of Deatsville. The quarry is 100 feet in length, 75 feet in breadth, and the height of the working face is 8 feet. It is in the gray limestone and is well suited for both building and road stone.

(13) *D. Meirfield Quarry.* This quarry is 2 miles west of Bloomfield. The top of the quarry is in the blue limestone and the bottom is in shale.

(14) *Ed Lewis Quarry.* This quarry is 2 miles north of Bloomfield. The quarry is in the blue limestone.

(15) *Henry Muire Quarry.* This quarry was within the city limits of Bardstown. In the early history of Bardstown this quarry furnished much stone for buildings, foundations, abutments, bridges, curbing, etc.

(16) This quarry is situated about 9 miles from Bardstown on the Bloomfield Pike. The stone is too soft and friable for either building or road work. The quarry should be abandoned.

(17) This is a small quarry one-half mile north of Deatsville. It is in the gray limestone.

Nicholas County

The terranes of Nicholas County are all in the Ordovician system. The Champlainian series, Lexington stage, forms a very narrow belt along the Licking River in the northeastern part of the county where the surface has been deeply intrenched by erosion. The Cynthiana limestone, which is also Champlainian, covers the southwestern part. The Cynthiana limestone is flanked on the northwest by the thin bedded Eden shale, Cincinnatian, which is in turn flanked by the Maysville limestone in the extreme eastern part.

The limestones are usually thin bedded and of gray to bluish gray color. The Eden shales are thin bedded, as can be

seen in the deep cut on the Maysville Branch of the Louisville & Nashville Railroad. The High Bridge series along the Licking River should furnish building stone for local use.

Paul D. Darnall, Road Engineer of Nicholas County, has kindly furnished the author with the following list of quarries for this county:

Name	Distance from Carlisle, Ky.	Owner	Pike Location	Foundation	Road Work
(1) Johnson	5 miles	County	Maysville & Lexington	Yes	Yes
2) Sims	1 mile	J. Sims	Upper Jackstown	Yes	Yes
(3) Piper	3 miles	W. L. Piper	Lower Jackstown	Yes	Yes
(4) Brady	1 mile	D. Westfall	Miller	Yes	No
(5) Barton	4 miles	County	Myers Station	Yes	Yes
(6) Linville	1½ miles	County	Scrub Grass	Yes	Yes
(7) Parker	1 mile	C. Hamilton	Moorefield	Yes	Yes
(8) Reinsmith	4 miles	County	East Union	Yes	Yes
(9) Weaver	8 miles	S. Weaver	Roost	Fair	No
(10) Bramblett	7 miles	H. Bramblett	Clark Road	Yes	Fair

No stone used for building purposes other than foundations.

Oldham County

The terranes of Oldham County belong to the Ordovician, Silurian and Devonian systems. The Maysville and Richmond formations of the Cincinnatian series cover the eastern, northern and western portions of the county. The Silurian rocks, Niagaran, occupy in general the central portion. The Devonian appears in a somewhat limited area in the southwestern part of the county.

The gray and blue limestones of the Maysville and Richmond formations in Oldham County are in general thin bedded and intercalated with shaly layers. There are some beds, however, that are sufficiently massive for building stone. This holds especially true along the Ohio River, where the limestone is sufficiently recrystalized to receive a good polish. The hard and resistant limestone of Floyd's Fork has been quarried and used for building purposes.

The Silurian formations, Niagaran, around La Grange, have furnished a valuable and durable stone for local use.

(1) *La Grange Quarry.* This is the quarry that has furnished stone for foundations, abutments, bridges, curbing, etc., around La Grange, the county seat of Oldham County.

Owen County

The terranes of Owen County are all Ordovician. The High Bridge and Lexington stages of the Champlainian series form the bluffs along the Kentucky River on the southwestern boundary of the county. These are overlaid by the Cynthiana limestone, also of the Champlainian series. The Cynthiana limestone also traverses the eastern part of the county. Nearly all of the area between the two outcrops of Cynthiana is covered by the Eden shales of the Cincinnatian series. This also holds true of the extreme eastern portion of Owen County. Around Owenton, the county seat, and northward from Owenton, the Maysville and Richmond beds occur.

Good building stones may be obtained in Owen County along the Kentucky River, where the High Bridge and Lexington outcrops form the high bluffs. Also in the Cynthiana formations in both the eastern and western portion of the county.

(1) *Owenton Quarry.* This quarry is near Owenton. It is in the blue limestone, and has furnished stone for buildings, abutments, bridges, culverts, curbing, etc., for local use.

(2) *Lockport Quarry.* This quarry is at Lockport on the Kentucky River, some 10 miles southwest of Owenton. It furnished the stone for the lock and dam at Lockport.

(3) *Monterey Quarry.* This quarry is on the Kentucky River, almost directly across the river from Gest. It is reported to have furnished stone for the same lock and dam as No. 2.

Pendleton County

The terranes of Pendleton County all belong to the Ordovician system. The Lexington stage of the Champlainian series forms a narrow outcrop along the Licking River and its South Fork. The Cynthiana limestone, also Champlainian, traverses the entire county along the streams and above the Lexington formation. The Cincinnatian series, Eden shales, practically covers the remainder of the county, but the Maysville limestone occurs in a very small outcrop in the western part of the county.

In general the limestones are thin bedded and intercalated with shaly layers. The thicker bedded, harder, more resistant gray, bluish gray, and dark gray beds afford some good building stone.

(1) *City Quarry.* This quarry is near Falmouth, the county seat. It has furnished some building stone for local use.

(2) *Ivor Quarry.* This quarry is situated at Ivor, a small station on the Chesapeake & Ohio Railroad in the extreme northeastern corner of the county. It has furnished some good building stone for local use. The stone has also been shipped in barges down the Ohio River to Newport for building purposes. The St. Paul's Episcopal Church in Newport on York and Court Place was erected with stone from this quarry in 1872. The stone is still in a good state of preservation.

(3) *County Quarry.* This is situated about 2½ miles south of Falmouth. It has a rock crusher and the stone is used for road work.

(4) This quarry is about 5 miles south of Falmouth. The stone is used in road work.

(5) This quarry is about 5 miles southwest of Falmouth. The stone can be used for building purpose. It is the best road metal in the county.

(6) This quarry is about 2 miles east of Falmouth. The stone is used for macadam.

(7) This quarry is about 3 miles northeast of Falmouth. The stone is used for macadam.

(8) *Trapp Brothers Quarry.* According to B. B. Barton, County Road Engineer, there is a good quarry at Menzie Station on the Louisville & Nashville Railroad, 8 miles north of Falmouth. There are 48 acres in the quarry land. The stone is suited for building purposes, foundations, curbing, and road construction.

Robertson County

The terranes of Robertson County belong to the Ordovician system. The Champlainian series is represented by a narrow band of Lexington limestone on the north bank of the Licking River. The Cynthiana limestone covers most of the southern half of the county. The Eden shales of the Cincinnatian series cover all of the northern half.

The limestones are generally thin bedded and intercalated somewhat with shaly members. The Lexington limestone along the Licking River and the Cynthiana limestone of the southern half of the county can furnish from the thicker and more resistant beds some good building stone for local use in both construction and macadam. These limestones are gray, bluish gray and rock gray in color. The Eden shales are too shaly and friable to furnish building stone. As no railroad traverses any part of this county only stone for local use can be expected.

(1) *County Quarry.* This quarry is situated a little south of Mt. Olivet, the county seat, and has furnished stone for building and macadam.

Scott County

The terranes of Scott County all belong to the Ordovician system. The Lexington limestone of the Champlainian series covers practically the entire southern portion. There are, however, a few outcrops of the Cynthiana in the southern half and a belt of Cynthiana outcrops stretches across the county a little

north of the center in a northwesterly direction. Of the Cincinnatian series the Eden shales are confined to the northern part and the Maysville and Richmond are not represented within the county at all.

Scott County is fortunate in possessing good building stone worthy of more than local use. The limestones and marbles are white or nearly white, grayish white, gray, bluish gray and dark gray in colors. The tendency of all is to weather white. In texture they range from fine grained to coarse grained. They are massive and thick bedded in most of the quarries. They are microcrystalline to completely recrystallized limestones which may be classified as marbles. Many of them are susceptible of a high and beautiful polish. They are well suited for decorative interior work as well as for purposes of massive construction, foundations, abutments, bridges, culverts, curbing, retaining walls, railroad ballast and macadam. A very beautiful sample of grayish white polished marble from Georgetown, the county seat of Scott County, can be seen in specimen No. 46, museum of Kentucky Geological Survey.

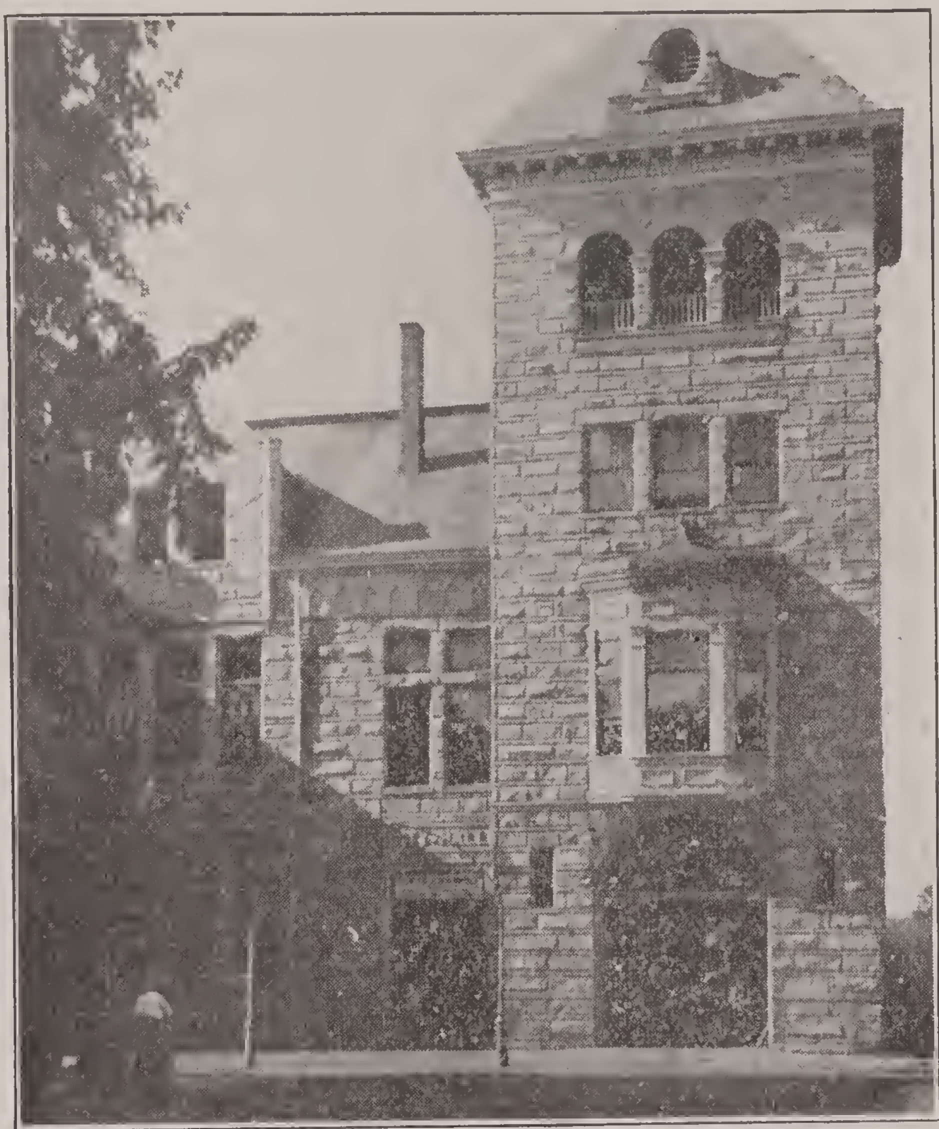
The limestones of Scott County have been used to a considerable extent locally for constructional purposes. The foundations of many homes carry them. The trimmings also contain them. The base course of the chapel of Georgetown College is local stone. The family vault of Dr. R. T. Bryan in Georgetown cemetery was erected from local stone in 1877-1878. The name plate on the door of the vault is polished marble from the Gaines quarry on Iron Works Pike near the southern boundary of the county.

(1) *Slaughter House Quarry.* This quarry is about 1 mile southeast of Georgetown. The stone is in part gray and in part grayish white in color, semi-crystalline to crystalline; and receives a good polish. This holds especially true of the lower 10 feet of stone in the quarry. The quarry is now owned by Mr. Hambrick. The length of the quarry is 200 feet, the breadth 50 feet, and the height of the working face is 20 feet. There is a crusher at this quarry.

(2) *Spedden Smith Quarry.* This quarry is within 50 rods of the Slaughter House quarry. It is a little smaller in

dimensions and the stone is a little darker in color. It is well crystallized, and susceptible of a high polish.

(3) *Albert Vaughn Quarry.* This quarry is situated about 50 rods south of the Slaughter House quarry and is about equal to it in size. An analysis of this stone was reported to give 99.5 per cent of carbonate of lime. If the report is correct, this is one of the purest limestones known. An old lime kiln was found here, and the stone formerly was burned for lime for both building and agricultural purposes.



62. CITY HALL, GEORGETOWN, KY.
This building at Georgetown, Scott County, Ky., was built of Rowan County freestone.

(4) *City Quarry.* This quarry is on the north side of the city, three-fourths of a mile from the courthouse. It has a crusher with a capacity of 100 tons per day. It is a good quarry.

(5) *Fannie Sumers Quarry.* This quarry is on the Lemons Mill Pike, 2½ miles southeast of Georgetown. It is a new quarry, opened in 1921, and the stone is used for road work.

(6) *Cane River Quarry.* This quarry is near Cane River on the farm of Felix Swope, 2½ miles southwest of Georgetown. It has a crusher of about a 100-ton capacity.

(7) *J. W. Osborne Quarry.* This quarry is on the Dixie Highway, 3 miles north of Georgetown. The rock is gray in color, very shaly, and no stone suitable for building purposes can be secured here. It is also a poor road stone.

(8) *Dr. F. F. Bryan Quarry.* This quarry is situated 3½ miles east of Georgetown. It is operated by the Frankfort and Cincinnati Railroad. The quarry is shaly on the top, gray and thicker bedded near the middle of the quarry, with the lower part of the quarry massive and thick bedded. It has a possible working face of 3,000 feet in length, and a height of 100 feet. It is a fine quarry.

(9) *Stamping Ground Quarry.* This quarry is situated one-half mile west of the Stamping Ground Station on the Frankfort & Cincinnati Railroad, 9 miles northwest of Georgetown. It is in the blue limestone and used for road work.

(10) *Gaines Quarry.* This quarry is on the Iron Works Pike, 4 miles south of Georgetown, and about 1 mile south of Donerail in Fayette County. It has furnished both building and monumental stone. It is inactive, but not exhausted.

(11) *Anderson Brown Quarry.* This quarry is on the Frankfort Pike, 3 miles west of Georgetown. The length of the quarry is 150 feet, the breadth is 5 feet, and the height of the working face is now 20 feet. It has a rock crusher of 150 tons capacity. There is but little stripping to do, and water is nearby for the boiler. It is the best quarry in the county.

Shelby County

The terranes of Shelby County belong to the Ordovician and Silurian systems. The only Champlainian outcrop is a small tongue of the Cynthiana limestone in the extreme eastern portion of the county. Of the Cincinnatian series the Eden shales cover the eastern portion of the county in a rather narrow belt, with the Maysville and Richmond stages covering the remainder of the county, save for two small areas of the Silurian rocks. The first of these is in the extreme northwestern part of the county to the east of Pewee Valley in Oldham County.

The second is an inlier well within the Bluegrass region to the southeast of Shelbyville, where the Jeptha Knobs form an exceedingly interesting monadnock. This monadnock can be seen to the southeast in traveling on the Louisville & Nashville Railroad from Shelbyville to Christiansburg.

The limestones as a rule are thinner bedded than they are in the heart of the Bluegrass region. They are gray or bluish gray in color. They are fine grained and even textured. According to W. M. Linney, stone was quarried in this county prior to 1880. The stone was used for building purposes, monumental work and road construction.

(1) This quarry is near Shelbyville, the county seat. The stone has been used for foundations, curbing, etc.

(2) *Harrisonville Quarry.* This quarry is in the extreme eastern portion of the county in the more massive and thicker bedded Cynthiana limestone. Rock was quarried here prior to 1880.

Spencer County

The terranes of Spencer County are practically all Ordovician in age. There is, however, in the extreme western portion a very narrow strip of Silurian rocks. The Ordovician terranes all belong to the Cincinnatian series. The Eden shales cover the eastern half of the county, while the western half is covered by the Maysville and Richmond formations.

The limestones are rather thin bedded and intercalated more or less with shale. They are gray and bluish gray in color, and fine grained. Some of them are micro-crystalline.

(1) *Taylorsville Quarry.* This quarry is situated a little to the northwest of Taylorsville, the county seat. It furnishes stone for building purposes in Taylorsville, as well as good stone for macadam.

Trimble County

The terranes of Trimble County belong to the Ordovician and Silurian systems. The Champlainian series is not represented in the county. Of the Cincinnatian series, the Eden shales are represented by a narrow outcrop in the eastern half of the county. The Maysville and Richmond formations cover most of the remaining area. A belt of Silurian outcrop traverses

the county from north to south through Bedford, the county seat, extending northward nearly to the Ohio River. The entire Silurian outcrop is surrounded by the Maysville and Richmond formations.

The thicker and more massive limestone beds of gray and bluish gray color furnish local building stone, and good stone for road work.

(1) One quarry was reported to exist about 4 miles south of Bedford which furnishes a building stone for local use.

Washington County

The terranes of Washington County all belong to the Ordovician system, save a single inlier of the Silurian system in the western part of the county. This inlier is entirely surrounded by Ordovician formations. The Champlainian series is represented by a limited outcrop of the Cynthiana limestone in the extreme northeastern portion of the county. Of the Cincinnatian series, the Eden shales cover the northeastern half, and the Maysville and Richmond formations the southwestern half.

The limestones are of gray, bluish gray, and dark gray color. They are fine to medium grained, granular to micro-crystalline, medium to thick bedded, and weather white. They have been quarried for many years and used for superstructures, foundations, abutments, bridges, culverts, curbing, railroad ballast and macadam.

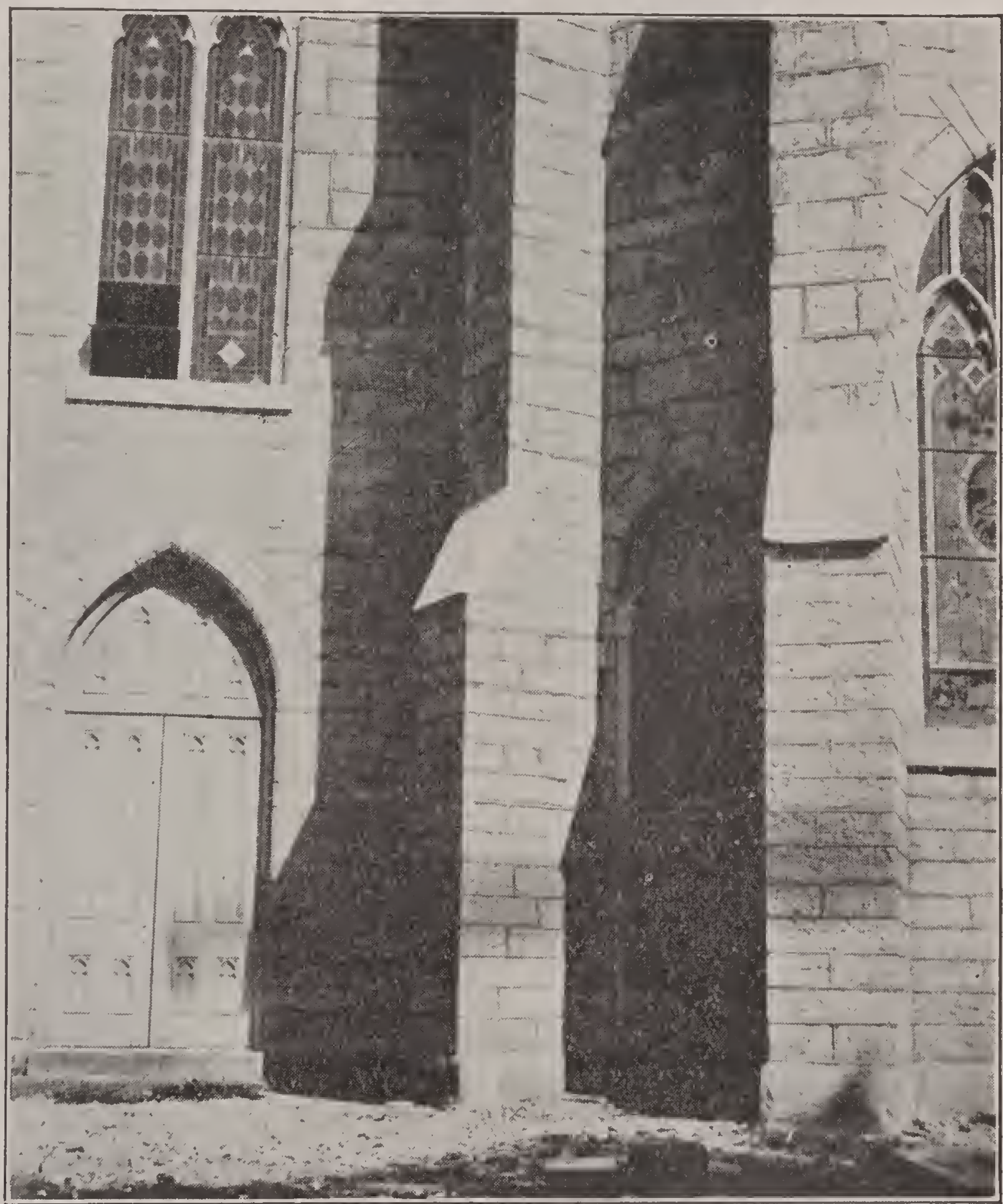
The best illustration in the county of the value and durability of this stone for building purposes is seen in the St. Rose Catholic Church at St. Rose, which was erected in 1854. After 68 years exposure to the corrosive agents of the atmosphere the stone is in a good state of preservation. A few blocks, now somewhat discolored, might have been avoided by a more judicious selection of the dimension stone. The white foundation and approach to St. Catharine Academy was built of local stone. The foundations of many structures and retaining walls in Springfield are of local stone. These are pleasing in their effect.

(1) *John Hall Quarry.* This quarry is also known as the McElroy quarry. It is situated at the east end of Main Street, and within the city limits. The stone is massive, light

gray in color, and was used in the foundations of the school building and the retaining walls around the grounds.

(2) *County Quarry.* This quarry is 1½ miles east of the courthouse on the lefthand side of the pike. The stone is used for macadam.

(3) There is a quarry also on the righthand side of the pike, almost directly opposite No. 2. The stone is used for macadam.



63. ST. ROSE CATHOLIC CHURCH, ST. ROSE, KY.
This church at St. Rose, Washington County, Ky., was built in 1854 from stone quarried near the church.

(4) *Pottsville Quarry.* This quarry is on the Springfield and Perryville Pike, 3 miles east of the courthouse. It contains some very good bluish gray micro-crystalline limestone.

(5) *County Quarry.* A quarry was reported 12 miles east of the courthouse. The stone is used for macadam. The quarry was not visited.

(6) *Valley Hill Quarry.* This quarry is situated 5 miles west of the courthouse. The stone is used for macadam.

(7) *Thompson Quarry.* This quarry is 7 miles north of the courthouse, and was said to contain very good road stone.

(8) *R. Horton Quarry.* This quarry is on the Willisburg Pike, 2½ miles north of the courthouse. It is in road stone.

64. OUTSIDE STONE CHIMNEY, SPRINGFIELD, KY.
This cut shows the value of stone in outside chimneys so common in Kentucky.

(9) *St. Rose Quarry.* This quarry is at St. Rose, 2½ miles south of Springfield. The stone for the St. Rose Catholic Church, erected in 1854, was quarried only a few rods beyond the church. It is a good building stone.

(10) *St. Catharine Quarry.* This quarry is some 3 miles south of Springfield. The quarry is abandoned because it is on the grounds of St. Catharine Academy, a female institute. The stone for the foundation and approach to this academy was quarried here. It is an excellent building stone.

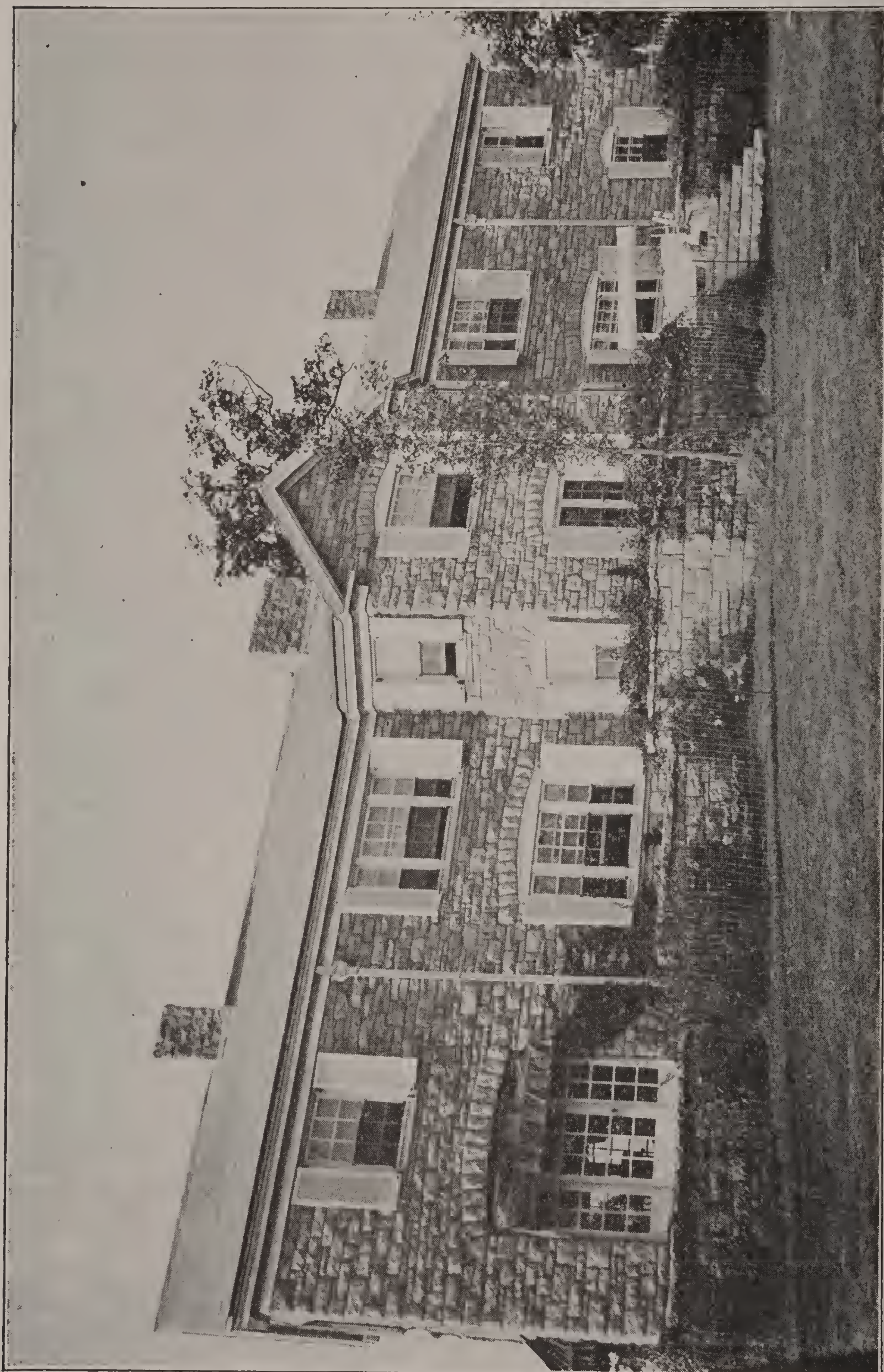
(11) *Willisburg Quarry.* A quarry was reported near Willisburg, the stone from which was used in the construction of the Willisburg Pike. Its location would be about 12 miles northeast of Springfield.

Woodford County

All the terranes of Woodford County belong to the Ordovician system. Furthermore, they are all in the Champlainian series. The High Bridge stage has all three of its members represented. The Camp Nelson bed extends from the southern boundary of the county as far north as Oregon, Mercer County. Here it disappears below the level of the river. The Oregon bed, Kentucky River Marble, disappears some 2 miles north of Oregon, Mercer County, while the Tyrone bed, Kentucky Marble, is continuous not only to the northern limit of the county, but to Steele Branch, 11 miles below Frankfort in Franklin County.

Aside from these high bluffs along the Kentucky River, nearly all of Woodford County is covered by the Lexington stage. The Cynthiana limestone furnishes a few isolated outcrops extending in a northwesterly and southeasterly direction across the county.

The thick bedded, massive, fine grained Camp Nelson bed, although it must be recognized as a building stone, has neither the beauty nor the value of the yellowish, cream colored, often mottled, Oregon bed, and the compact, fine grained, white to light dove colored Tyrone bed. These three divisions, known as the High Bridge stage, can furnish an inexhaustible supply of most excellent building stone. The very light gray, gray, and bluish gray, granular to crystalline Lexington limestone contains beds well suited for constructional work. An illustration of this type may be found in the Jesse quarry, 2 miles east



65. RESIDENCE OF GEORGE M. BAKER.

This home is on the Versailles-Glens Creek Pike, Woodford County, Ky. It shows the value of Kentucky limestone in a private residence.

of Versailles, the county seat. This stone is light gray, very hard, well crystallized, and when sawed rather than split, would make a very satisfactory building stone.

66. GATEWAY TO "HEREFORD FARM."
This cut shows the main entrance to the E. H. Taylor, Jr., farm, Versailles, Woodford County, Ky. It was built of local limestone.

(1) *Jesse Quarry.* This quarry is situated 2 miles east of Versailles on the left side of the Versailles and Lexington Pike. The rock is massive, hard, thick bedded, with individual beds from 2 to 4 feet in thickness. It is so hard that it breaks up with much difficulty into proper dimensions for road work. It is far better suited for building purposes. It would make a good building stone if it were sawed into dimension blocks.

(2) This quarry is near the intersection of the Nicholasville Pike and the Dry Ridge Pike, 1 mile south of Versailles. The stone is used for macadam.

(3) *Faywood Quarry.* This quarry is at Faywood, on the Frankfort and Lexington Pike, 7 miles northeast of Versailles. The stone is used for macadam.

(4) *Midway Quarry.* This quarry is located at Midway, on the Versailles and Midway Pike, about 9 miles north of Versailles. The stone has been used in foundations, curbing, etc., at Midway, and for road construction. It is a very good quarry.

(5) This quarry is on the Harrodsburg Pike, 10 miles south of Versailles. The quarry is in good building stone.

(6) *McCowans Ferry Quarry.* This quarry is near McCowans Ferry, 3 miles southwest of Versailles. The stone is fine for building purposes.

(7) *Mundy's Landing Quarry.* This quarry is near Mundy's Landing, on the Kentucky River. Much stone has been quarried here for constructional work. It is a good building stone.

(8) *Oregon Quarry.* This quarry is at Oregon, on the Kentucky River, about 8 miles south of Versailles. Stone was quarried here for the lock and dam No. 6 on the Kentucky River. The stone is fine for building purposes.

(9) This quarry is on Shryocks Pike, about 3 miles southwest of Versailles. The quarry is in building stone.

(10) *Clifton Quarry.* This quarry is on the Clifton Pike, 6 miles west of Versailles. It is in building stone.

(11) This quarry is on the McCrackens Mill Road, 5 miles northwest of Versailles. It is in building stone.

(12) *Camden Farm Quarry.* This quarry is on the Frankfort Pike, about 3 miles northwest of Versailles. The stone is a road metal.

(13) *Crutcher Quarry.* This quarry is on the Crutcher estate, 6½ miles northwest of Versailles. It is a very good quarry for both building purposes and road work.

(14) This quarry is on the McCrackens Mill Road, 7 miles northwest of Versailles. It is used as road metal.

(15) *Duckers Station Quarry.* This quarry is at Duckers Station, 8 miles northwest of Versailles. The stone is used for macadam.

(16) This quarry is on the Leestown Pike, 12 miles north of Versailles. The quarry is in good building stone and fine road stone.

(17) According to Frank Danforth, Topographic Surveyor of the United States Geological Survey, this quarry is situated three-fourths of a mile east of Shryocks Ferry. It is a new quarry in fairly thick bedded, dark gray limestone. The quarry has a crusher, and the stone is considered very good for road construction.

Number of County.	Name of County.	Number of Quarries in County.
37	Anderson	1
38	Bath	3
39	Boone	1
40	Bourbon	10
41	Boyle	10
42	Bracken	3
43	Bullitt	5
44	Campbell	4
45	Carroll	1
46	Clark	18
47	Fayette	37
48	Fleming	24
49	Franklin	9
50	Gallatin	1
51	Garrard	2
52	Grant	1
53	Harrison	10
54	Henry	5
55	Jefferson	18
56	Jessamine	7
57	Kenton	3
58	Lincoln	4
59	Madison	4
60	Marion	16
61	Mason	35
62	Mercer	6
63	Montgomery	25
64	Nelson	17
65	Nicholas	10
66	Oldham	1
67	Owen	4
68	Pendleton	8
69	Robertson	1
70	Scott	11
71	Shelby	2
72	Spencer	1
73	Trimble	1
74	Washington	11
75	Woodford	17
Total number of quarries		347

CHAPTER VIII

THE MISSISSIPPIAN OUTCROPS OF CENTRAL, SOUTHERN AND WESTERN KENTUCKY

The Mississippian outcrops of central, southern and western Kentucky, as included in this chapter, embraces the Mississippian formations that lie beneath the Bluegrass region of north central Kentucky on the east and the Pennsylvanian coal measures on the west. The counties of Grayson and Edmonson, which are about equally represented in the Mississippian and Pennsylvanian are included in this chapter, for they are not distinctively in the western coal measures. The chapter includes the counties that lie between the western coal measures on the north and the Tennessee boundary on the south. Furthermore, it includes those counties which lie between the western coal measures on the northeast and the Jackson Purchase on the southwest. Twenty-seven counties are listed and described in this chapter.

The terranes described in this chapter are predominantly Mississippian. A little Ordovician, Silurian, Devonian and Pennsylvanian are of necessity included with the Mississippian. These outcrops will be noted as they occur in the respective counties containing them.

Adair County

All the terranes of Adair County belong to the Mississippian system, save two small areas in the northeastern part of the county, which are Devonian in age. The larger of these outcrops is along the upper courses of Green River, and the smaller is along Casey Creek, a small tributary to Green River from the north.

Nearly all of Adair County is covered by the Waverlian series of the Mississippian. The Mammoth Cave limestone traverses the southwestern part of the county in a northwesterly and southeasterly direction. The Chester, which is the uppermost series of the Mississippian, is not represented.

The building stones of Adair County are all limestones. The Warsaw stage of the Waverlian series can furnish a limestone for local use in construction. In color it ranges from gray to bluish gray, and in texture it is medium to coarse grained.

The quarry near Columbia, the county seat, is in this formation. The Mammoth Cave limestone of the southwestern part of the county can furnish good building material. The stone is white to grayish white in color, and even textured.

(1) *Trabue Quarry.* This quarry is 1½ miles west of Columbia. The color of the stone varies from blue to bluish gray. The thickness of the individual beds varies from 6 inches to 2 feet. The stone has been used for building purposes in Columbia, and for macadam.

(2) According to L. O. Taylor, Accountant of Department of Public Roads, Frankfort, Ky., this quarry is situated near the city limits of Columbia. It is massive, thick bedded, well crystallized, and of dark gray color. The stone is being used in the concrete foundations for the new Bank of Columbia and other buildings in Columbia. It is also used for macadam. The sample submitted to the author is a good building stone.

(3) This quarry is situated 15 miles south of Columbia. The stone is yellowish white in color, and was used in the trimmings of the courthouse at Columbia. This stone caps the Knobs in the southern part of the county.

Allen County

Nearly all the terranes of Allen County belong to the Mississippian system. A very narrow outcrop of Silurian and Devonian rocks occur along the eastern boundary of the county, extending in a northerly and southerly direction. Where the Allen County line turns due east, these formations send a branch due east also, and then both branches extend in a southerly direction to the Tennessee boundary. In the southern part of the county there is a very narrow belt of Silurian and Devonian rocks extending in a northwesterly direction for only a few miles.

The building stones are confined to the Mississippian formations. The Waverlian series covers nearly all of the county. The Mammoth Cave limestone occurs in Allen County only as a narrow belt along the northwestern and western boundaries.

The oldest building stone in the county is the Fort Payne formation, which covers nearly all of the southeastern half. This probably is Cuyahogan. The Warsaw limestones cover nearly

all of the northwestern half. The St. Louis limestone, a stage of the Mammoth Cave series, outcrops in the northwestern and western portions of the county.

The limestones are of light gray, gray, and bluish gray colors. They are fine to medium grained, and sufficiently thick bedded to furnish dimension stone. They have not, however, been quarried for anything more than local use.

(1) This quarry is situated in the ravine one-half mile west of Scottsville, the county seat. The stone is drab in color, fine grained, and rather soft. It contains nodules of chert, a chalcedonic variety of quartz, which injures the value of the stone somewhat for constructional work. The softness of the stone lowers its value as a road stone. It has, however, been used in base courses, underpinnings, culverts, bridges, abutments, and macadam.

(2) This quarry is situated one mile southeast of Scottsville, just off the Holland Pike. The quarry is much larger than the one to the west of Scottsville. A considerable amount of stone has been removed and used largely as road metal. The quarry has a crusher with a capacity of 100 tons per day. A part of the quarry product has been used for building purposes. The stone is good for constructional work. Both of these quarries are in the Fort Payne formation.

Barren County

The terranes of Barren County belong to the Silurian, Devonian and Mississippian systems. The Silurian limestone occurs only as a narrow belt along Barren River in the southern part of the county. This Silurian limestone is overlain by a narrow belt of Devonian limestone, which is in turn flanked by a narrow belt of Chattanooga shale, which is also Devonian.

The Mississippian system is represented by the Waverly, Mammoth Cave and Chester series. The Waverlian series is represented by the Fort Payne formation, which covers nearly one-half of the southeastern portion of the county, and the Warsaw limestone, which covers most of the central portion. The Mammoth Cave series is represented by the St. Louis and St. Genevieve formations. The St. Louis limestone outcrops to the east of Glasgow and flanks the Warsaw limestone on the north.

The main outcrops of the Gasper and St. Genevieve oolitic limestones lie in the northwestern portion, but the Gasper and St. Genevieve formations are not divided here. The Chester series comprises the Gasper, oolitic limestone, already mentioned, and the Cypress sandstone. The latter formation covers the extreme northwestern portion, and has 3 isolated outcrops in the northeastern part of the county.

The limestone members furnish the building stones for Barren County. The nodular, cryptocrystalline, chalcedonic chert in the Fort Payne formation renders it less desirable for building purposes than the overlying bluish gray, gray, and often dark gray Warsaw limestone. This limestone is semicrystalline to completely recrystallized, and often suscepitable of a high polish. The St. Louis limestone is well crystallized and susceptible of a good polish. It can furnish fine dimension blocks. The Gasper and St. Genevieve formations are white, oolitic limestones that can furnish excellent building stone. These limestones are massive and thick bedded. Various members of the limestone formation have been used for building purposes in Glasgow, the county seat of Barren County.

(1) *City Quarry.* This quarry is situated within the city limits on the northwest side of the City of Glasgow. The quarry opening is 200 feet in length, 100 feet in breadth, and 50 feet in the height of the working face. The quarry has a crusher with a capacity of 100 tons per day. The individual beds vary from 1 to 8 feet in thickness. The thicker beds are of medium to coarse grained texture, with perfect rift and grain. They vary in color from light gray, medium gray, to a chocolate brown or reddish color, and are well crystallized. The stone is susceptible of a good polish. The polished surface suggests some of the cedar marbles of Tennessee. A large polished sample of the Glasgow marble can be seen in the museum of the Kentucky Geological Survey. The stone is not only well suited for massive construction, foundations, abutments, bridges, culverts, retaining walls, curbing and road work, but also for decorative interior work as panelling, bordering, wainscotting, and inlaid floors. For these latter uses it is especially desirable. The thicker beds from this quarry could easily be manufactured

into polished marble slabs, which would bring the larger returns to the city and the State.

(2) *Thomas Dickinson Quarry.* This quarry is situated on the Jackson Pike, 2 miles north of Glasgow. The limestone here is compact, in part oolitic, thick bedded, of medium gray color, and well suited for building purposes. This quarry was inactive.

(3) *Harvey Quarry.* This quarry is on the Jackson Highway, 3½ miles north of Glasgow. The quarry opening was small, for it was just being opened for use on the Jackson Highway. A study of the surrounding outcrops and topography revealed the possibility of a very large quarry at this site. The stone is compact, thick bedded, rather dark gray color, well recrystallized, traversed by stylolites, and is a good building stone, as well as an excellent road stone.

(4) This quarry is on the Jackson Highway, 9½ miles north of Glasgow. The individual beds vary from 2 to 5 feet in thickness. The rift and grain are perfect. The stone is of white to very light gray color, oolitic, and would make a very satisfactory building stone. Its distance from Glasgow adds to the expense of using the stone for constructional purposes, for which it is so well suited.

(5) *Matthews Quarry.* This quarry is situated at Temple Hill, approximately 8 miles southeast of Glasgow. The stone is dark gray in color, massive, thick bedded, and well crystallized. It is a good building stone, road stone, and agricultural stone.

(6) *John Owens Quarry.* This inactive quarry is situated 1½ miles north of Cave City, near the Hart County line. This quarry, which assumes the aspect of a mining prospect, is in Mexican onyx. Blocks of onyx marble have been obtained here 5 feet in length, 2½ feet in breadth, and 2 feet in thickness. The stone is translucent, banded with beautiful colors, and susceptible of a high polish.

(7) *E. Ford Quarry.* This inactive quarry is situated three-fourths of a mile west of Cave City. The opening is in Mexican onyx. Blocks of onyx marble have been obtained here 4 feet in length, 2½ feet in width, and 16 inches in thickness. A part of the onyx is very white and banded, and a part of it is a sienna yellow and partially recrystallized.

(8) *Show Quarry.* This quarry is one-fourth mile off the Mammoth Cave road, according to S. S. Garby. Blocks of Mexican onyx have been obtained here that were 6½ feet in length, 4½ feet in width, and 2½ feet in thickness, and 11,000 pounds of the stone has been shipped to Louisville for decorative interior work.

(9) According to S. S. Garby, there is a possible quarry in Mexican onyx on land owned by E. Ford, 2 miles southwest of Cave City on the Dixie Highway. Mr. Garby states that solid blocks of red Mexican onyx can here be secured as large as a railroad car. The property was not visited by the author.

Breckinridge County

The terranes of Breckinridge County are essentially Mississippian. There are a few outcrops of the Pennsylvanian system in the extreme western part of the county. The Mississippian system is represented by the Mammoth Cave and Chester series. The Mammoth Cave limestone covers only a small area in the northeastern part of the county. The remainder of the county, save for the Pennsylvanian outcrops mentioned above, belongs to the Chester series.

The limestones are light gray, gray, and bluish gray in color, fine to medium grained, massive, and thick bedded. The Hardinsburg sandstone splits readily into slabs suitable for flagging purposes.

(1) This quarry is situated on the Ohio River, on the Louisville, Henderson & St. Louis Railroad, about 1 mile east of Cloverport. The limestone is bluish gray and thick bedded. It is in the Glen Dean formation. The stone is suitable for building purposes, although it is used for macadam.

(2) *Beard Brothers Quarry.* According to P. M. Bashun, County Judge, this quarry is at Hardinsburg, the county seat, but it was not visited by the author. The stone has been used for foundation work in Hardinsburg.

(3) *S. W. Davis Quarry.* This quarry is situated at Mystic, a small station on the Louisville, Henderson & St. Louis Railroad, about 10 miles north of Hardinsburg. The quarry is in the Freedonia member of the St. Genevieve oolitic limestone. It

represents a building stone, and is used for railroad ballast and road work.

(4) *Webster Stone Company Quarry.* This quarry is at Webster, a station on the Louisville, Henderson & St. Louis Railroad, some 10 miles northeast of Hardinsburg. The stone is used for railroad ballast, road metal, and agricultural lime. It is the Freedonia member of the St. Genevieve limestone.

(5) This quarry is situated about 1 mile south of Sinking Creek, on the Fordsville Branch of the Louisville, Henderson & St. Louis Railroad. The top of the quarry is in a dark gray, siliceous, oolitic limestone, Gasper, in which there are many small granules of quartz about 1 millimeter in diameter. The bottom of the quarry is in a siliceous limestone containing numerous rounded pebbles of an oolitic limestone. This is also Gasper. The stone is used for railroad ballast and macadam.

(6) *Irvington Quarry.* A quarry was reported at Irvington to be in the Gasper oolitic limestone. The length of the quarry was said to be 150 feet, the breadth 100 feet, and the height 90 feet.

Caldwell County

The terranes of Caldwell County are mostly Mississippian in age. The Pennsylvanian system forms a rather narrow outcrop in the northern and northeastern portions of the county. Of the Mississippian system the Waverlian series is wanting. The Mammoth Cave series covers the southwestern portion of the county, and the Chester series covers the central portion.

The building stones of Caldwell County are essentially limestones. These are white to grayish white in color, fine grained, even textured, oolitic limestones of the Freedonia formation. The oolites are mostly round, but some of them are elongated. The limestone is often traversed by narrow zigzag bands of darker material that gives striking contrasts on the polished surfaces. The stone is susceptible of a polish. The stone is well suited for all types of constructional work.

Some of the Chester sandstones around Princeton have been used for building purposes. They are very friable when freshly quarried, but they are reported to harden on exposure to the atmosphere. At the quarries a 10-pound sample dropped

through 5 feet of space is crushed to an excellent glass or building sand upon striking the floor of the quarry.

(1) *Katterjohn Quarry.* This quarry is operated by the F. W. Katterjohn Construction Company, and the output largely used by the Illinois Central Railroad. The quarry is situated 3 miles southeast of Princeton, the county seat, at Cedar Hill. The shipping point is Cedar Bluff, on the Illinois Central Railroad. The quarry is one of the largest and best in Kentucky. The length of the quarry is 1,000 feet, the breadth is 300 feet, and the maximum height of the working face is 200 feet. The quarry was opened in 1902. The uper part of the quarry is in the Ohara limestone and the lower part in the Freedonia limestone. Both formations belong to the St. Genevieve stage of the Mammoth Cave limestone series.

67. KATTERJOHN QUARRY, CEDAR HILL, KY.

The quarry of the F. W. Katterjohn Construction Company is at Cedar Hill, Caldwell County, Ky. Beneath the floor of the quarry there is 20 feet of excellent white, oolitic building stone.

The capacity of the crusher at this plant is 1,500 tons per day. Five different sizes of stone are produced: No. 1 is 2½ inches in diameter; No. 2 is 1½ inches in diameter; No. 3 is

$1\frac{1}{4}$ inches in diameter; No. 4 is $\frac{5}{8}$ inch in diameter, and No. 5 is $\frac{1}{4}$ inch in diameter to dust.

Beneath the floor of this quarry there is a 20-foot bed of massive, fine grained, light gray to nearly white oolitic limestone. This limestone, on account of its freedom from iron, its whiteness of color, its oolitic uniform texture, its perfect rift and grain, would make a most excellent building stone for superstructures. The opening in this bed is in the left hand corner of the quarry. A hand sample was collected here that is traversed by a narrow vein of fluorite.

(2) *E. Boaz Quarry.* This quarry is on the Princeton and Cadiz Pike, 3 miles south of Princeton. This quarry was opened several years before the Civil War. The stone was sawed, and used for foundations at Princeton, monumental work, and burned for lime. It was used in the base courses of the courthouse at Princeton in 1865. It weathers well, and is oolitic.

(3) *M. U. Lamb Quarry.* This quarry is situated on the Hopkinsville and Eddyville Pike, 4 miles southwest of Princeton. The stone was used in the construction of the pike. Both the white and blue limestones occur here.

(4) *W. F. Holman Quarry.* This quarry is situated about $1\frac{1}{4}$ miles northeast of Princeton and about three-fourths of a mile from the Illinois Central Railroad. The quarry opening is about 150 feet in length. This quarry is in a very friable sandstone. The lower 30 feet of this sandstone is white or nearly white in color, fine to medium grained, with the individual sand grains rounded to subangular in shape. The upper 20 feet is iron stained on the surface, but yellowish white when broken. The most of the stone quarried here has been used in the manufacture of mortar and cement. The stone is too friable for constructional work.

(5) *Thomas Young Quarry.* This quarry is situated 1 mile northeast of Princeton. It is now owned by W. F. Holman. The stone is approximately identical with that in No. 4, and has been used for the same purposes.

(6) To the north of Princeton many stone chimneys have been built of sandstone from small local quarries or prospects. The stone has also been used for abutments of bridges, and for culverts. Some of these northern sandstones are fine grained,

of yellowish brown color, and weather a yellowish brown. Others are coarser in texture, and weather reddish brown. They belong to the Chester series.

Casey County

The terranes of Casey County belong to the Ordovician, Devonian and Mississippian systems. The prevailing system is the Mississippian. The Ordovician system, Maysville and Richmond outcrops, appear in the northern part of the county in two narrow belts, one extending east and west nearly across the county, the other extending somewhat southwesterly for a short distance from Lincoln County. The Devonian rocks flank the east and west Ordovician outcrop on both the north and the south, and the southwesterly outcrop on both the northwest and the southeast side, but in the latter case the Devonian terranes extend in a southwesterly direction across the entire county. The most of Casey County is covered by the Waverlian series of the Mississippian system. The Mammoth Cave limestone forms a rather narrow outcrop in the southern part of the county, and the Chester series is not represented.

Many of the limestones of the Waverlian series are of gray, bluish gray and dark gray color, certain beds of which could furnish good building stone. The white to grayish white Mammoth Cave limestone should furnish a good building stone for local use in this county. Liberty is the county seat of Casey County. This county was not visited.

Christian County

The terranes of Christian County belong to the Mississippian and Pennsylvanian systems. The Pennsylvanian system is represented only in the extreme northern part of the county. All of Christian County south of Hopkinsville, the county seat, is occupied by the Mammoth Cave series of the Mississippian system. The rocks are therefore relatively pure limestone. The Chester series of the Mississippian system flank the Mammoth Cave limestone on the north, and the Pennsylvanian formations on the south.

The best building stones of Christian County are found in the white or grayish white Mammoth Cave limestone. This is

thick bedded and weathers white. Hopkinsville is located on the Ste. Genevieve limestone, which is easily recognized by the above named characteristics. The Gasper oolite of the Chester series can furnish excellent building stone. In some sections of Christian County the Gasper oolite is very thick bedded and more compact than it is at the Green River quarries in Warren County. The oolitic limestones have been used in constructional work around Hopkinsville.

68. COOKS STONE COMPANY QUARRY.

This quarry is near Hopkinsville, Christian County, Ky. The cut shows much broken stone and the thickness of the individual beds.

(1) *Cooks Stone Company Quarry.* This quarry is situated just outside the city limits of Hopkinsville. It is about 500 feet in length, 100 feet in breadth, and the height of the working face is approximately 40 feet. It has a rock crusher with a capacity of 150 tons per day.

Most of the stone in this quarry is a white to grayish white oolite. The oolites are mostly round, but a few of them are elongated. It is remarkably free from iron and weathers white. It is fine grained, semi-crystallized, thick bedded, and traversed by a few very narrow zigzag bands of a darker hue. The thicker beds reach a maximum of 10 feet. This stone is susceptible of a polish, and is a building stone of high grade. It works

69. A ROCK CRUSHER, HOPKINSVILLE, KY.

This cut shows the rock crusher of the Cook Stone Company, Hopkinsville, Christian County, Ky.

easily and breaks with a conchoidal fracture In the lower part of the quarry there is a drab to dark gray limestone bearing a few flint nodules.

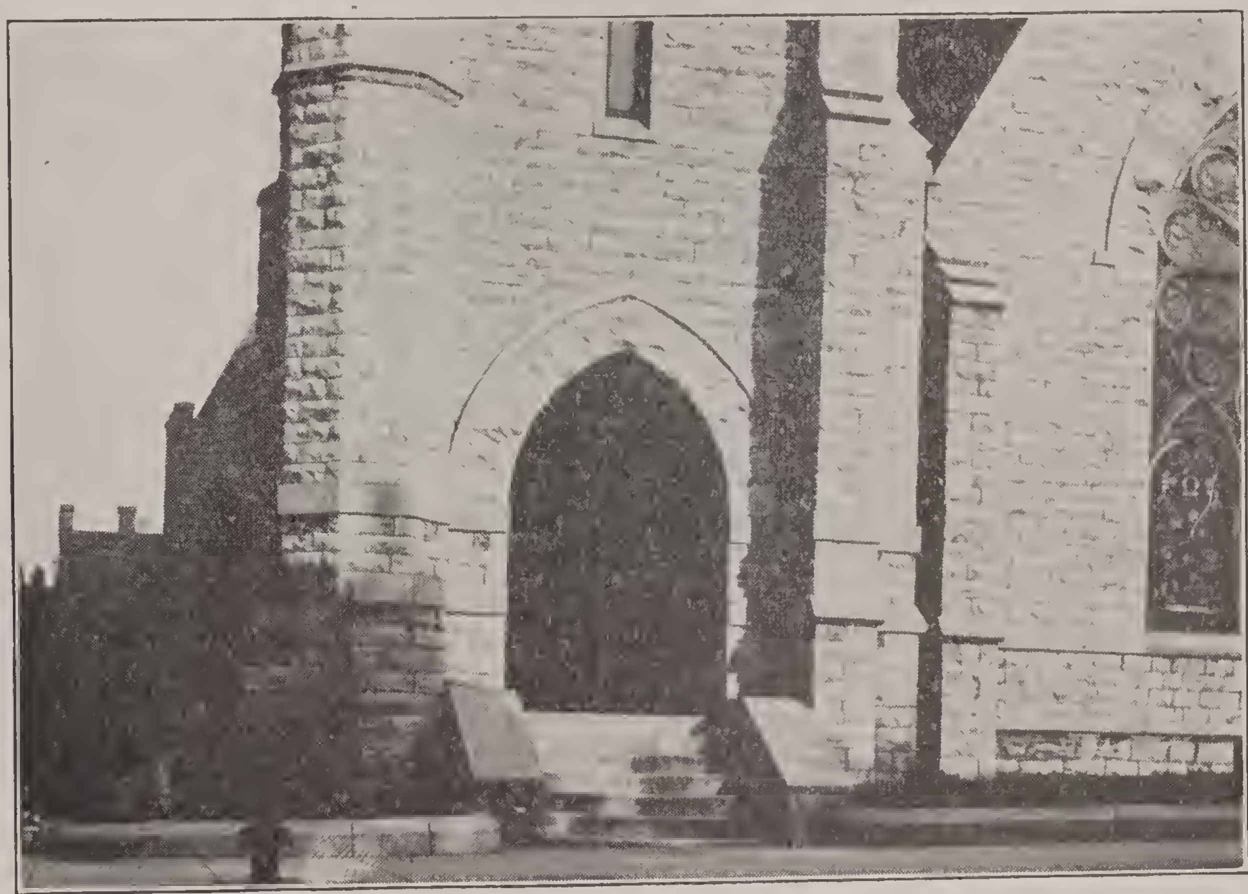
70. CITY BANK AND TRUST COMPANY.

This structure is at Hopkinsville, Christian County, Ky. The front of the bank contains Bowling Green white oolitic limestone.

(2) *Hopkinsville Stone Company Quarry.* The output of this quarry is utilized by the Louisville & Nashville Railroad. It contains good building stone.

(3) *Planters Hardware Company Quarry.* The output of this quarry is utilized by the Louisville & Nashville Railroad. It contains good building stone.

(4) *W. S. Davidson Quarry.* This quarry is situated a little ways off the Louisville & Nashville Railroad and is operated by the City of Hopkinsville. The stone is excellent for building purposes.



71. FIRST BAPTIST CHURCH, HOPKINSVILLE, KY.
This church was built of Bowling Green white oolitic limestone.

Crittenden County

Most of the terranes of Crittenden County belong to the Mississippian system. The Pennsylvanian system is represented in outcrops stretching across the entire northeastern portion of the county. They extend in a southwesterly direction along the southeasterly boundary for a considerable distance. There are several oval-shaped inliers of the Pennsylvanian system well within the Mississippian terranes. Of the Mississippian system, the Warsaw series is wanting. The Mammoth Cave

limestone series is represented in the southern part of the county. The Chester series occupies a larger area than the Mammoth Cave limestone series and the Pennsylvanian system combined.

The Mammoth Cave limestone series is represented by the white oolitic Freedonia limestone, which is an excellent building stone, the calcareous Rosiclare sandstone and the Ohara limestone. According to Charles Butts, the Bethel sandstone of the Chester series is especially well developed $3\frac{1}{2}$ miles west of Marion, the county seat of Crittenden County. The Gasper oolite has been identified in Crittenden County only in the eastern part, about 2 miles south of Craneyville.

Local limestones have been used around Marion for underpinning and curbing, but no quarries in them were located by the author.

(1) *Lemuel Clark Quarry.* This quarry is about three-fourths of a mile east of the courthouse on the farm owned by Lemuel Clark and his son. The quarry is in a sandstone, which is pure white or yellowish white in color, and very friable. The product has been shipped to Evansville, Indiana, for manufacture of glass. It has been used in the manufacture of brick for consumption around Marion, and as a building sand. It is too friable for dimension blocks.

(2) *Dr. O. C. Cook Quarry.* This small quarry is about 20 rods north of the Second Baptist Church of Marion. The stone has been used for base courses, curbing, paving and flagging. It is not a good stone for dimension blocks.

Cumberland County

According to the State Geologic Map, the terranes of Cumberland County belong to the Ordovician, Devonian and Mississippian systems. A belt of Ordovician strata, Maysville and Richmond, stretches across the entire county in a northeasterly direction where erosion has been carried to the lower levels by the Cumberland River and its tributaries. The Ordovician terranes are flanked upon either side by the Devonian. The Mississippian rocks, therefore, cover the northwestern and southeastern portions of the county. The northwestern portion is covered by the Waverlian series and the southeastern by the Mammoth Cave series.

The building stones of Cumberland County are bluish gray and blue limestones. The hard, thick bedded layers along the Cumberland River should furnish building stone for local use around Burkesville, the county seat. A quarry was reported to furnish stone for foundation work in Burkesville, but it was not visited.

Edmonson County

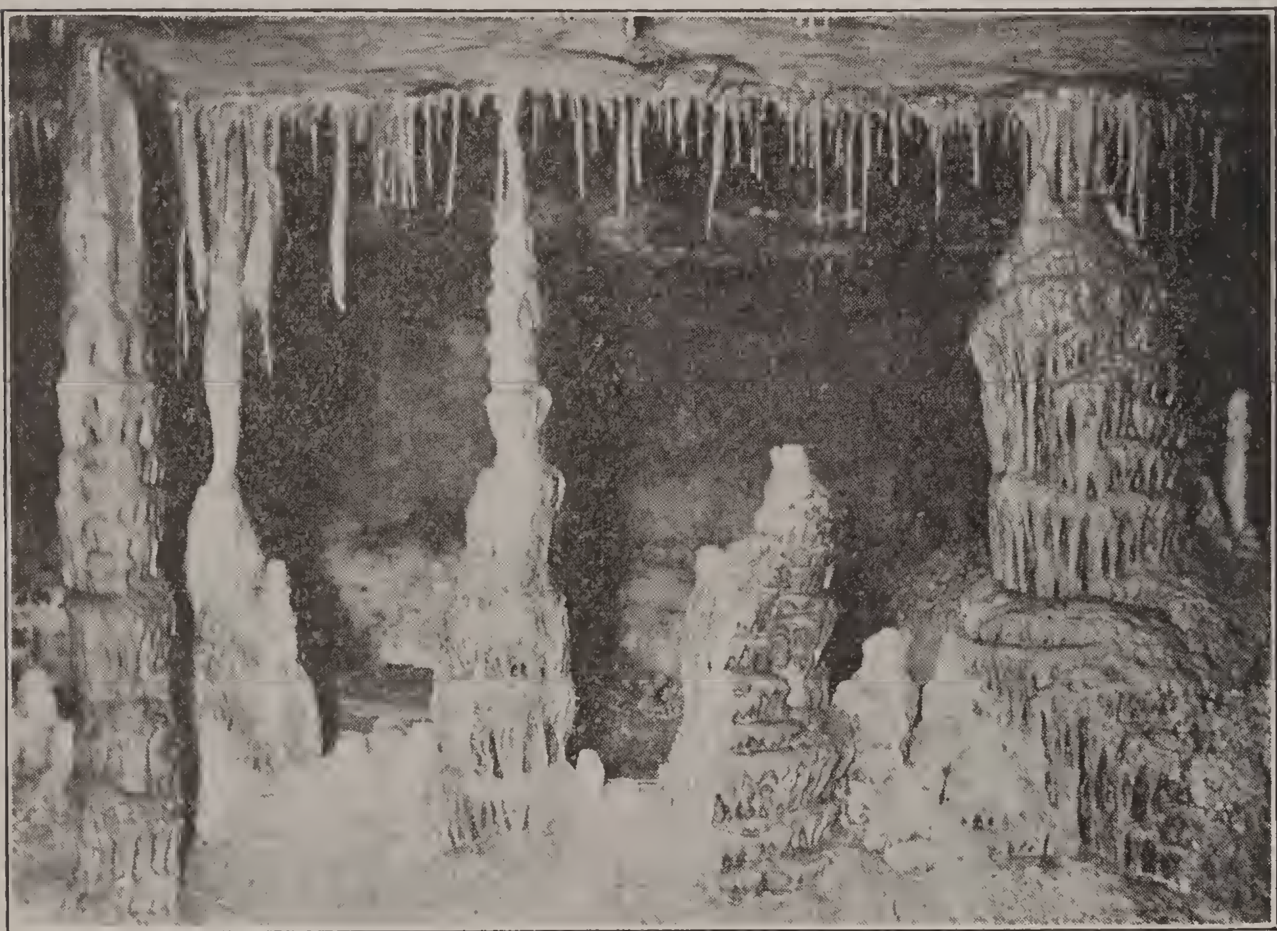
The terranes of Edmonson County belong to the Mississippian and Pennsylvanian systems. The former covers the southern half of the county, the latter occupies the northern half, with the exception of two narrow belts of Mississippian outcrops in the Pennsylvanian system. The Mammoth Cave limestone series

72. BEAUTIFUL FORMATIONS IN COLOSSAL CAVERN.
Colossal Cavern is in Edmonson County, Ky. Photo by the Louisville and Nashville Railroad.

covers the more southern portions of the county. The Chester series occupy the belt between the Mammoth Cave series on the south and the Pennsylvanian system on the north. The two

narrow belts of Mississippian outcrops in the Pennsylvanian area belong to the Chester series.

The limestones of Edmonson County are white, light gray, gray, and dark gray in color. They are medium grained and coarse grained. They are mostly oolitic. Some of them are very compact, with vitreous luster, and break with a conchoidal fracture. They are thick bedded and can produce good building stone.



73. COLONNADE OF MEXICAN ONYX.
This colonnade is in Great Onyx Cave, Edmonson County, Ky. Photo by L. P. Edwards.

The Freedonia oolitic limestone is noted for its abundant sink holes and caves which have given rise to a "karst" country pitted with sinks, with drainage largely underground. Mammoth Cave, Great Onyx Cave, Colossal Cave, Crystal Cave, White Cave, and numerous smaller caves in Edmonson County, are in this formation. These caves contain an appreciable amount of Mexican onyx or onyx marble, in the form of stalactites, stalagmites, columns, pilasters, and grotesque images. Onyx marble is noted for its translucency, delicacy of colors, fineness of grain, and compactness. Its variations in color and texture,

to which its ornamental character is largely due, are commonly produced by impurities or inclusions, such as oxides of iron, or even mud and clay. In chemical composition, they are usually calcite, $CaCO_3$, and rarely the orthorhombic form of calcium carbonate known as aragonite. Waters charged with calcium carbonate enter these caves and by relief of pressure and evaporation the calcium carbonate is thrown out of solution. This Mexican onyx is the onyx of Pliny and Horace, and must not be confused with the onyx of Theopbrastus, which was a cryptocrysalline, or flint-like, variety of quartz, SiO_2, which is deposited from solution in layers of different colors, as white and black, white and brown, white and red. The alternating layers are in even planes, and the banding straight, rather than in irregular lines as in the agates.

In the author's judgment, the cave region of Edmonson County should be made a National Park. Outside the immediate vicinity of the caves, there should be discovered beds of Mexican onyx, or onyx marble, that would be of considerable commercial value. Onyx marble is susceptible of a high polish and highly prized for decorative interior work.

(1) One quarry was reported near Brownsville, the county seat, which has furnished a small amount of stone for local foundation work. The quarry is reported to be in oolitic limestone.

Grayson County

The terrancs of Grayson County belong to the Mississippian and Pennsylvanian systems. The Mississippian system occupies the northern and eastern part of the county, and the Pennsylvanian system the southern and western part. In this county the Warsaw and Mammoth Cave series of the Mississippian system are entirely wanting, and therefore only the Chester series appears as outcrops. These are limestones and sandstones.

The limestones are white, gray, and bluish gray in color, and weather white. They are fine to medium grained, and some of them are thick bedded. The sandstones are yellowish white to white, medium grained, and weather a yellowish white to a yellowish brown. Both the limestones and the sandstones have been quarried and used for foundations, abutments, bridges, curbing, and retaining walls around Leitchfield, the county seat.

(1) *W. J. Cunningham Quarry.* This quarry is situated one-half mile southeast of Leitchfield. The quarry is 250 feet in length, 50 feet in depth, with a height of working face of 15 feet. The quarry is in a hard, bluish gray, tough limestone, that breaks with an angular fracture. The product is used by the county in road building, and is considered a very good road stone.

(2) *Polly Owens Quarry.* This quarry is one-fourth mile southwest of the courthouse. The rock is limestone.

(3) *Berry Quarry.* This quarry is one-fourth mile northeast of the courthouse. The quarry is in limestone.

(4) *R. L. Morman Quarry.* This quarry is 1½ miles west of Leitchfield. The quarry is in limestone.

(5) *W. O. Jones Quarry.* This quarry is 1 mile northwest of the courthouse. The quarry is in sandstone.

(6) *L. Decker Quarry.* This quarry is one-fourth mile southeast of the courthouse. The quarry is in sandstone. The stone for the base of the courthouse at Leitchfield came from this quarry.

(7) *George Meredith Quarry.* This quarry is 1 mile east of the courthouse. The quarry is in limestone.

(8) *Lile Quarry.* This quarry is on the Elizabethtown Pike, 2 miles east of the courthouse. The quarry is in limestone.

(9) *Hardin Porter Quarry.* This quarry is at Yeaman, 18 miles west of the courthouse. The quarry is in limestone.

(10) *John White Quarry.* This quarry is 2 miles north of the courthouse. The quarry is in limestone.

(11) *Charles Stenson Prospect.* On the farm of Charles Stenson, 1 mile northwest of the courthouse, there is a bed of very white, fine grained, oolitic limestone that would make a most excellent building stone.

(12) *James Cook Prospect.* On the farm of James Cook at Meredith, 5 miles south of Leitchfield, there is a sandstone that is even bedded, and works easily into small dimension blocks, but it is better suited for the manufacture of hone stones.

(13) *Illinois Central Quarry.* This quarry is situated 2 miles north of Grayson Springs, near the Illinois Central Rail-

road. The individual beds of gray limestone are 4 feet in thickness. The quarry is considered very good for building purposes and railroad ballast.

Green County

All the terranes of Green County belong to the Mississippian system. Most of the county is traversed by the Waverlian series. The Mammoth Cave limestone series stretches across the county from north to south in a rather narrow belt near the center of the county.

The possible building stones are limestones of light gray, gray, bluish gray and dark gray color. Good building stone should be found in the Mammoth Cave limestone series.

(1) This quarry was reported to be in the Mammoth Cave series near Greensburg, the county seat, and to furnish building stone for local use around Greensburg.

Hardin County

All the terranes of Hardin County belong to the Mississippian system, save for a narrow belt of Devonian shale in the extreme eastern part of the county. The Waverlian series in a very narrow outcrop flanks the Devonian terranes on the west. The Mammoth Cave limestone series covers nearly all of the remaining area. The Chester series occupies a small area in the southeastern part of the county.

The building stones are therefore essentially limestones. They are of white, light gray, gray and bluish gray colors. Some of them are fine grained, some are medium grained, others are coarse grained and oolitic. Usually they are thick bedded, and weather white.

(1) *McMurtry Quarry.* This quarry is situated just outside the city limits of Elizabethtown, the county seat, on the east side of the city. The quarry is in thick bedded limestone. It represents a good building stone and a good road stone.

(2) *Government Quarry.* This quarry is on the Dixie Highway, 4 miles south of West Point. The quarry is 100 feet in length, 40 feet in breadth, with height of working face 40 feet. The individual beds are from 2 to 4 feet in thickness. It is an excellent building stone and a good road stone.

(3) *West Point Quarry.* This quarry is at West Point on the Illinois Central and Louisville, Henderson & St. Louis Railroads. The stone has been used largely in railroad construction, but the quarry is now inactive because the stone is regarded as too soft for road construction. The quarry has a working face of 100 feet.

74. SILMAN QUARRY, STEPHENSBURG, KY.
This quarry is near Stephensburg, Hardin County, Ky. The cut shows the thickness of the individual beds.

(4) *Silman Stone Quarry.* This quarry is on the Illinois Central Railroad at J. 51, 1 mile south of Stephensburg. The length of the quarry is 1,350 feet, the breadth is 400 feet, and the height of the working face is 62 feet. A section in this quarry gave the following thicknesses:

10 feet bluish gray crystalline limestone, top.
3 feet grayish white marble, well crystallized.
12 feet gray limestone.
14 feet bluish gray hard limestone.
5 feet magnesian limestone.
8 feet white to buff limestone.

The 14 foot bed of hard, bluish gray limestone is called by the quarrymen "Bell metal rock" because it rings under the hammer. It is very massive and breaks with a conchoidal fracture. It is regarded as the best road stone in the quarry. The quarry was opened in 1912 and has been in continuous opera-

tion ever since. It carries a crusher with a 450-ton daily capacity. The stone is used by the Illinois Central Railroad for abutments, bridges, and ballast, and by Hardin County and Camp Knox in the construction of permanent roads.

(5) *J. C. Hix Quarry.* This quarry is situated 1 mile west of Stephensburg, with roadbed and right of way owned by the Illinois Central Railroad. The stone is very good for building purposes.

(6) *Brown-Goodin Company Quarry.* This quarry is at Upton, on the Louisville & Nashville Railroad, in the extreme southern part of the county. It is a very large quarry, and the product is used by the Louisville & Nashville Railroad.

Hart County

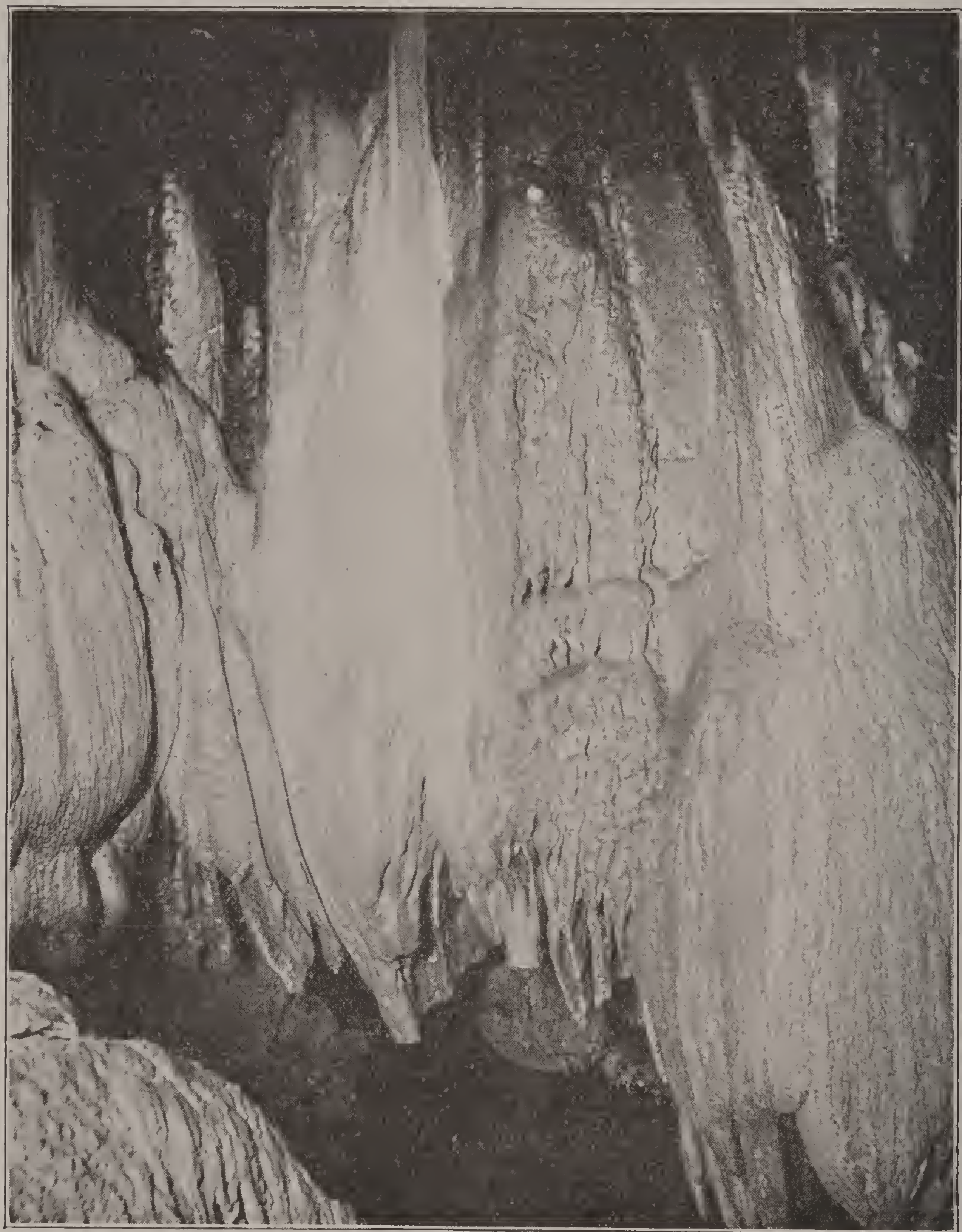
The terranes of Hart County belong to the Mississippian and Pennsylvanian systems. The outcrops of the Pennsylvanian system are limited to a small area in the western part, and a narrow tongue of shallow deposits that extend in a northeasterly direction across the county. The Mississippian system is represented by the Mammoth Cave limestone series, which covers the greater part of the county, and the Chester series, which outcrops in the western part.

The building stones of Hart County are chiefly the coarsely oolitic, thick bedded, Freedonia limestone, and the oolitic Gasper limestone. According to Charles Butts, the numerous bluffs visible from the Louisville & Nashville Railroad between Russellville and Elizabethtown are in the Gasper oolite.

(1) *Munfordville Quarry.* This quarry is situated on the east side of the Louisville & Nashville Railroad, 4 miles north of Munfordville, the county seat. The quarry is 150 feet in length, 100 feet in breadth, and the height of the working face is 90 feet. The upper 10 feet of the quarry is in a yellowish white, much decomposed limestone. The remainder of the quarry is in the white, oolitic, Gasper limestone. It is rather soft, works easily, and is an excellent building stone. It is largely used in road construction.

(2) *Hammonville Quarry.* This quarry is in road stone near the boundary between Hart and Larue Counties, northeast of Hammonville.

(3) *Pilot Knob Quarry.* This quarry is situated 20 miles due east of Horse Cave. The quarry is in Mexican onyx or onyx marble. About 25 years ago 2,000 pounds of this onyx was



75. STALACTITES OF MEXICAN ONYX.
These stalactites are in Mammoth Onyx Cave, near Horse Cave, Hart County, Ky. Photo by Dr. Harry Thomas.

shipped for decorative interior work, and pronounced very good. A second order was placed, filled, but never paid for. This act led to the discouragement of the company, and the quarry was

abandoned. Reliable parties familiar with Pilot Knob report much Mexican onyx in the area. The samples seen by the writer are exceedingly fine grained, beautifully banded, translucent and susceptible of a high polish. With modern auto-truck methods of haulage this quarry should be reopened.

(4) *Dan Carpenter Prospect.* This possibility of a Mexican onyx quarry is situated just outside the corporate limits of Horse Cave and about 10 rods to the right of the Dixie Highway on the road to the Mammoth Onyx Cave which might well be called Mexican Onyx Cave.

(5) *Barren River Prospect.* According to C. L. Jewell of Horse Cave there are large deposits of Mexican onyx about 20 miles from Horse Cave along Barren River. Some of these outcrops are from 20 to 30 feet in height, and beautifully banded. The beds are said to be thick and lie in a horizontal position. This suggests spring deposits.

(6) *Horse Cave Prospect.* According to W. C. Gibson, Secretary of the Chamber of Commerce, Horse Cave, the largest deposits of Mexican onyx in Kentucky are along the lines of Hart, Barren and Edmonson Counties, with the best deposits in Hart County, about 3 miles southwest of Horse Cave. A 50-acre tract of land in the last named section was sold to an eastern company in 1917 or 1918 for more than $70,000.00, and the deed recorded in Hart County. The war interfered with developments at that time, but it is understood that active quarry operations are to begin within a few months.

Larue County

The terranes of Larue County belong to the Devonian and the Mississippian systems. The Devonian shales occupy only a narrow belt in the extreme eastern portion. The Mississippian formations contain a very narrow belt of Waverlian rocks flanking the Devonian on the west. Nearly all of the county is covered by the Mammoth Cave limestone series. The Chester series is not represented.

The building stones of Larue County are therefore limestones. They are white, grayish white, gray and bluish gray in color, fine to medium grained, and thick bedded.

(1) *Tonieville Quarry.* This quarry is situated at Tonieville, 6 miles northwest of Hodgenville, the county seat. It can furnish good building stone.

(2) *Walter Lane Quarry.* This quarry is at Buffalo, 5½ miles southeast of Hodgenville. The stone is heavy and even bedded. There are several good quarry sites at Buffalo, and all could produce building stone as well as road metal.

(3) *Nolin Quarry.* This quarry is near Nolin, and near the intersection of North Fork and South Fork of Nolin River. There is much good stone here for local use.

Livingston County

The terranes of Livingston County belong to the Mississippian and Pennsylvanian systems. The former covers the entire county, save a few isolated outcrops of the latter. The Waverlian series of the Mississippian system is wanting. The Mammoth Cave limestone series is represented only in the extreme eastern part. The prevailing outcrops are members of the Chester series. The building stones are in the Chester formations.

The constructional rocks of Livingston County comprise both limestones and sandstones or quartzites. The limestones are fine grained, gray in color, and thick bedded. The quartzose terrane is medium grained, white in color, and thick bedded.

(1) *Barrett Company Quarry.* According to J. T. Madison, General Inspector of New Roads, Frankfort, Ky., there is a good sized quarry in the gray limestone formations 4½ miles northeast of Smithland, the county seat of Livingston County. It is furthermore on the north side of the Cumberland River. The quarry product is a good building stone, and is largely sold to the United States Government for the construction of locks and dams.

(2) *Quarry Prospect.* This prospect is located 3 miles south of Smithland. The prospect has a good working face of from 20 to 30 feet. The rock is practically pure white to a faintly yellowish white, medium grained quartz sand recemented by pure quartz, and therefore a quartzite. It is the hardest and most resistant rock known in the State. The original sandstone may have been converted into a quartzite along fault lines through the influence of rock movements due to faulting. The

area is extensive, and well worthy of careful investigation for both building stone and road metal.

The following letter is from Mr. F. H. Hillyard, Resident Engineer of Smithland, Ky., to Mr. J. T. Madison, General Inspector, Frankfort, Ky.:

. . . the Oscar F. Barrett new quarry is just being opened up and at present has a face of about fifteen feet by two thousand. This face is from twenty to seventy-five feet from the face of the main cliff which when worked back will average one hundred feet high. The present face is covered with a talus slope overburden of from three to five feet. The stone in the new quarry is practically all the same as the sample. No equipment is used at present but churn and steam drills, blasting apparatus, a loading derrick, and tugs and barges for transportation. All of the present output is used by the government and other river improvement agencies. The stone is broken by hand into ten-pound chunks and larger, and is used for rip rap, slope paving, and jetty construction. It is the plan of the management as soon as the new quarry is worked back far enough to give room to install a large crushing plant for both road and agricultural purposes. The only means of transportation at present is by river, but a road could be opened to the Salem road about a mile distant, or loaded by cable cars across the river a short distance from the Smithland-Vicksburg road.

The old quarry which is not being worked at present is located one-half mile nearer Smithland or north of the new. This face is about two thousand feet long, but only about twenty feet high. It has about the same thickness of ledges, that is, from three to eight feet, as the new quarry. The major portion of this stone is of the same character as the sample, however one end of the face is of whiter softer material. This quarry cannot be worked in extreme high water. Some of this material has been crushed at various times by private concerns for agricultural purposes. No road material has ever been used from either of these quarries.

(3) *Nunn Quarry.* This quarry is situated near Nunn Station. The quarry is in limestone and the product used for abutments, bridges, culverts, etc.

Logan County

The terranes of Logan County belong to the Mississippian and Pennsylvanian systems. The Pennsylvanian outcrops, however, are confined to a small area in the extreme northwestern part of the county. The Waverlian series of the Mississippian

is wanting. The Mammoth Cave limestone series covers the entire southern portion, and the Chester series the northern portion, save the northwestern corner of the county, which as mentioned above, is Pennsylvanian.

The building stones are limestones. These are white, grayish, gray and bluish gray in color. They are fine to medium grained, even textured, and thick bedded. Some of them are pronouncedly oolitic, and excellent building stones.

(1) *W. J. Sparks Quarry.* This quarry is situated on the Morgantown Pike, 1½ miles northeast of Russellville, the county seat. In this quarry there is 30 feet of white, oolitic, thick bedded, crystalline limestone. Its fine grain, even texture, uniform color, perfect rift and grain, and susceptibility of a polish, make this rock an excellent building stone. There is also 20 feet of very compact, drab colored limestone that could be used for building purposes. The product, however, is largely used for railroad ballast and macadam. The quarry is 500 feet in length, 400 feet in breadth, and with height of working face 50 feet.

(2) *Trapp Quarry.* This quarry is on the Greenville Pike, 2 miles northwest of Russellville. The quarry is 500 feet in length, 200 feet in depth, with 20 feet of rock exposed above the water level. The depth of the water was reported to be over 30 feet. The water could easily be pumped out and the quarry reworked. There is much good building stone here. When the quarry was active the product was largely shipped to Owensboro for constructional work.

(3) *Burger Quarry.* This quarry is on the Hopkinsville Pike, 1½ miles west of Russellville. The quarry face is 200 feet in length, the breadth is 50 feet, and the height of the working face is 20 feet. The individual beds are from 4 to 6 feet in thickness, very compact, and of bluish gray color, weathering a grayish white. This quarry furnished the foundation stone for the various buildings of Bethel College at Russellville. The mausoleum in the Russellville cemetery came from the white, crystalline bed just west of the Burger quarry. It was built by Burger and Grinter 42 years ago, and shows well the value of this stone in constructional work.

(4) *County Quarry.* This quarry is on the Nashville Pike, 1 mile south of Russellville. The output is used by the town and county in the construction of streets and permanent roads.

(5) This quarry is situated a little to the northeast of No. 4. The stone is used for foundations, abutments, bridges, culverts, and curbing.

(6) This quarry is situated on the Greenville Pike, 3 miles north of Russellville. It furnished the stone steps for the Administration Building of Bethel College. It is now inactive.

Lyon County

The terranes of Lyon County belong to the Mississippian and Cretaceous systems. The Cretaceous deposits are confined to a small area in the southwestern part of the county, between the Cumberland and Tennessee Rivers. The Waverlian and Chester series of the Mississippian system are wanting. The prevailing rocks therefore belong to the Mammoth Cave limestone series.

The building stones of Lyon County are limestones. They are of medium gray to dark gray color and weather a slightly grayish white. They are medium grained to coarse grained, oolitic, thick bedded limestones. The oolitic texture is far more pronounced on the polished surface than it is in either hand samples or the quarry face. It is semi-crystallized, and the coarse aggregations of the calcite as seen on the polished face suggest a conglomerate. Some layers are traversed by zigzag bands of darker material. The largest structure known to have been built of this stone is the State Penitentiary at Eddyville. This structure illustrates well the value of this product as a building stone. The stone has been used largely in Eddyville for foundations, retaining walls, and curbing.

(1) *Gen. H. B. Lyon Quarry.* This quarry is situated 2½ miles southeast of Eddyville, the county seat of Lyon County. The quarry product is a very hard, medium gray, medium to coarse grained, semi-crystalline, oolitic limestone. The quarry is some 300 feet in length, 60 feet in breadth, and with height of working face of 25 feet. It is from this quarry that the stone was obtained for the construction of the Administra-

tion Building and cell houses Nos. 1, 2 and 3 of the State Penitentiary at Eddyville, 1882-1885. The stone, now grayish white in color, is very pleasing in its architectural effect. Cell house No. 4 was built of Bowling Green stone in 1904.

76. SOLDIERS MONUMENT, RUSSELLVILLE, KY.
This monument is at Russellville, Logan County, Ky. It was built of white crystalline and oolitic limestone.

(2) *W. H. Long Quarry.* This quarry is 1¼ miles northeast of the courthouse. It is a very massive, dark gray, semicrystalline limestone that weathers a very light gray. This stone was used in the high walls around the Penitentiary. These walls enclose 10 acres.

(3) *County Quarry.* This quarry is 1 mile southeast of Eddyville. Crushed stone was obtained here for road work. The quarry is now inactive.

(4) *H. B. Lyon Quarry.* This quarry is 3 miles southeast of the courthouse. The stone was burned for lime for constructional and agricultural purposes.

(5) *Coffer Dam Quarry.* This quarry is situated within the corporate limits, and the stone is being used in the construction of the coffer dam.

(6) *Big Spring Quarry.* This quarry is in the east end of Eddyville. The stone was used in the construction of some parts of the Penitentiary.

(7) *Cliff Quarry.* This quarry is one-half mile north of the courthouse. The stone is used for foundations, abutments, bridges, culverts, curbing and chimneys at Eddyville.

(8) *C. W. Emery Quarry.* This quarry, which is now inactive, is situated 1½ miles west of Grand Rivers in a thick bedded limestone that weathers white. The stone from this quarry was used in the two large iron furnaces at Grand Rivers. It makes a very good building stone.

Meade County

The terranes of Meade County all belong to the Mississippian system. The Mississippian system is represented by a small outcrop of the Waverlian series alnog the Ohio River in the northeastern corner of the county. The Mammoth Cave limestone series covers about four-fifths of the area within the county. The Chester series outcrops in the northern and northwestern part, and occurs also as small isolated patches in the southern part.

So far as known to the author, all the quarries in Meade County are in the limestone members of the different series. The limestones vary widely in texture from the fine grained lithographic limestone to the coarsely crystalline St. Louis limestone. In color they are drab, light gray and dark gray.

(1) *Lithographic Limestone Quarry.* This quarry is situated about one-half mile north of Brandenburg, the county seat. As the name implies, the quarry is in the lithographic limestone. The product is largely used in the preservation of stock patterns, for it lends itself readily to delicate carving. The stone is highly argillaceous. In cases of extreme weathering, it yields a clay product. The stone is not equal to the famous lithographic limestone of Solenhofen, Bavaria, yet it is in good demand and commands high prices.

(2) *Portland Cement Plant Quarry.* The large Portland Cement Plant at Kosmosdale secures its limestone from a large quarry about 8 miles southeast of Brandenburg, near the Ohio River.

(3) *Local Quarry.* According to J. Morgan Richardson, attorney at law, Brandenburg, the stone fence around the court-house came from a local quarry. The stone becomes laminated upon long continued exposure to the atmosphere. The stone has also been used for foundations and curbing.

Metcalfe County

All the terranes of Metcalfe County belong to the Mississippian system. Nearly all the area is covered by the Waverlian series. The Mammoth Cave limestone series covers the northwestern portion of the county. The Chester series is wanting. The Waverlian and Mammoth Cave formations should furnish building stone for local use. One quarry was reported to exist near Edmonton, the county seat, which has furnished stone for foundations and curbing at Edmonton. This county is not penetrated by the railroads, and was not visited by the author.

Monroe County

The terranes of Monroe County belong to the Ordovician, Devonian and Mississippian systems. The Ordovician outcrops are in the southeastern part of the county, along the Cumberland River. They belong to the Maysville and Richmond formations. These should contain beds of limestone sufficiently thick and crystalline for building purposes. The Devonian shales flank the Ordovician outcrops on both sides. The remainder of the county is covered by the Waverlian series of the Mississippian system.

(1) One quarry was reported in the Waverlian series near Tompkinsville, the county seat. The product is used for foundations and curbing in Tompkinsville.

Russell County

The terranes of Russell County belong to the Ordovician, Devonian and Mississippian systems. The Ordovician terranes are confined to the southern part of the county, where the Cumberland River has carried erosion to the lower levels. The outcrops belong to the Maysville and Richmond formations. These are flanked both on the north and the south by the Devonian shales. The Waverlian series of the Mississippian system covers

the western and northwestern area, and the Mammoth Cave limestone series the central portion. The Chester series is wanting.

The building stones of Russell County are therefore limestones. The Maysville and Richmond formations of the Cincinnatian series are sufficiently thick bedded and crystalline to furnish building stone for local use. The white, light gray and gray, thick bedded, Mammoth Cave limestone can furnish good building stone.

(1) One quarry was reported near Jamestown, the county seat. This quarry is said to furnish stone for foundation and curbing in Jamestown.

According to H. W. Edmonds, County Judge of Russell County, there is an abundance of blue stone within the county. The stone, however, has never been extensively quarried. The beds vary from 3 to 6 feet in thickness wherever it has been quarried.

Simpson County

The terranes of Simpson County are all Mississippian. The Waverlian series is absent. Likewise the Chester series. The entire county, therefore, is occupied by the Mammoth Cave limestone series.

The limestones are white, grayish white, and gray. They are often oolitic and thick bedded. They can furnish good building stone.

(1) *Walter Stringer Quarry.* This quarry is situated about 4 miles west of Franklin, the county seat of Simpson County. The stone is used for foundations, abutments, bridges, curbing, and road metal.

(2) This quarry is on the Blackjack Road about 5 miles east of Franklin. The stone is used as road metal.

Taylor County

The terranes of Taylor County belong to the Devonian and Mississippian systems. The Devonian formations occupy only a small narrow area extending in a northeasterly and southwesterly direction along Robinson Creek in the northeastern part of the county. The Waverlian series of the Mississippian sys-

tem covers nearly all of the remaining area. In the extreme northwest corner of the county there is a small area occupied by the Mammoth Cave limestone series.

The limestones are gray and bluish gray in color, fine to medium grained, and sufficiently thick bedded to furnish building stone for local use.

(1) One quarry was reported near Campbellsville, the county seat. This quarry was said to furnish stone for foundation work and curbing, as well as road metal.

Todd County

The terranes of Todd County belong to the Mississippian and Pennsylvanian formations. The Pennsylvanian outcrops are confined to the northern part of the county. The Waverlian series of the Mississippian system is wanting. The Mammoth Cave limestone series covers all of the southern half of the county, and the Chester series the northern part.

The limestones of Todd County are white, grayish white, and bluish gray in color. They are in part oolitic, medium to coarse grained, thick bedded, and can furnish good building stone.

(1) *E. L. Traugher Quarry.* This quarry is situated on the Russellville Pike about 4 miles west of Elkton, the county seat of Todd County. The quarry is in the white, oolitic limestone. It is a good building stone, but it is largely used in the construction of permanent roads.

(2) There is an abandoned quarry just west of Elkton that has furnished much stone for retaining walls, fences and foundations.

(3) This quarry is just out of Elkton, to the east. The stone has been used in foundation work.

(4) *Rev. W. Miller Quarry.* This quarry is situated 2 miles northeast of Elkton. The stone is white in color, oolitic, and a fine building stone.

(5) *Sugg Quarry.* This quarry is on the Elkton-Russellville Pike, 5 miles east of Elkton. This quarry is in the white, oolitic, limestone. The stone is well suited for constructional work.

Trigg County

The terranes of Trigg County belong to the Mississippian and Cretaceous systems. The Cretaceous deposits are confined to the area between the Cumberland and Tennessee Rivers, and are roughly parallel with the northwesterly course of these two streams. The Waverlian series of the Mississippian system is wanting. The Mammoth Cave limestone series covers nearly the entire county. The Chester series occupies only a very limited area in the extreme northeast corner of the county.

The limestones are white, grayish white, gray, and bluish gray in color. They are in part oolitic, medium to coarse grained, thick bedded, and can furnish good building stone.

(1) *Cerulean Stone Company Quarry.* This quarry is situated 1½ miles north of Cerulean. It is 650 feet in length, 600 feet in breadth, and the height of the working face is 53 feet. At the top of the quarry there is 10 feet of light gray, oolitic, building stone underlain by 30 feet of very hard, dark gray, massive limestone that breaks with a conchoidal fracture. At the bottom of the quarry there is 15 feet of massive, dark gray limestone that is not flinty in character. This quarry operates a gyrating Gates crusher with 400-ton capacity.

(2) *Charles McQuerry Quarry.* This quarry is situated one-half mile west of Cerulean, and the product is used for road construction.

(3) This quarry is situated 1 mile south of Cerulean. The stone here is broken into dimension stone by hand only.

(4) *Cadiz Quarry.* A quarry was reported to exist a little north of Cadiz, the county seat. The stone was said to be used for foundation work and curbing at Cadiz. The quarry was not visited by the author.

Warren County

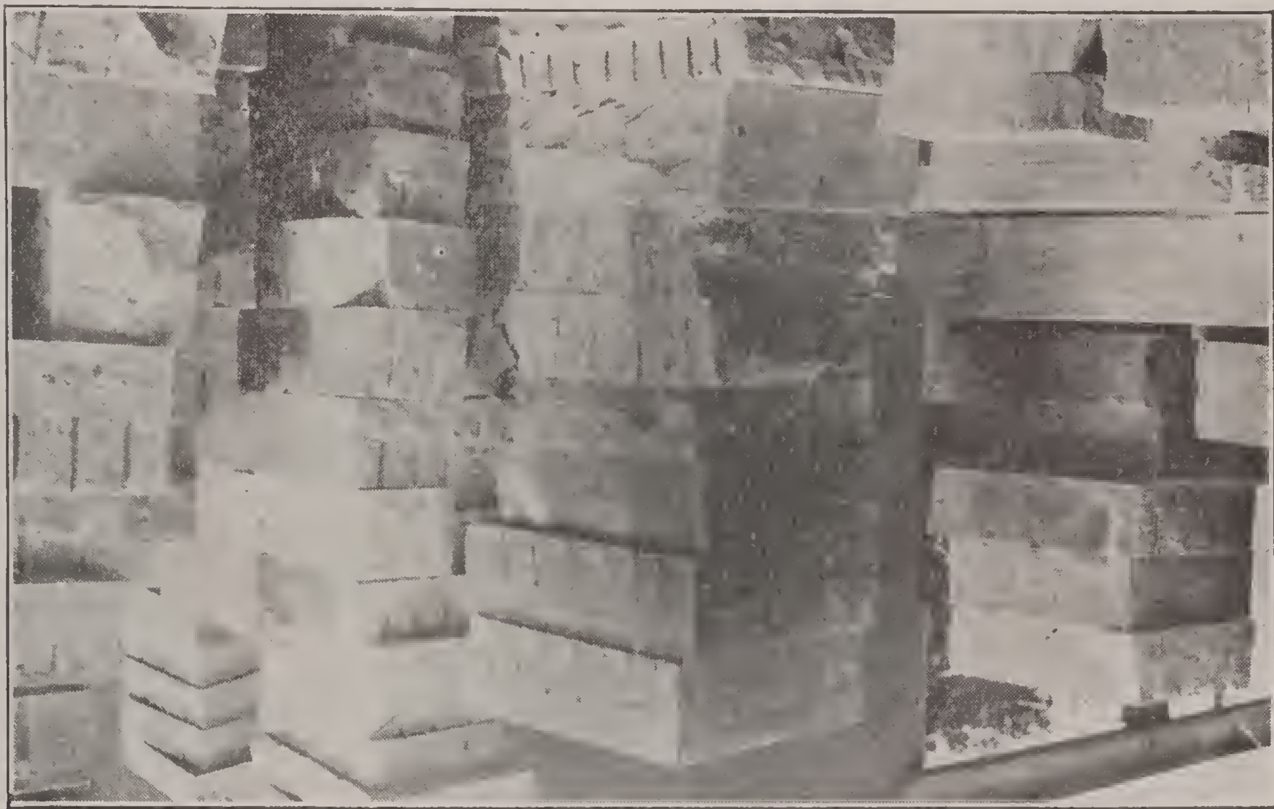
The terranes of Warren County belong to the Mississippian and Pennsylvanian systems. The Pennsylvanian formations are confined to a few outcrops in the extreme northern part of the county. The Waverlian series of the Mississippian system is wanting. According to the maps prepared by Prof. Arthur M.

Miller the Mammoth Cave limestone series covers nearly the entire county, the Chester series outcrops mainly in the northern part of the county.

77. BOWLING GREEN QUARRIES CUTTING PLANT.
This plant is located just outside of the city limits of Bowling Green, Warren County, Ky.

The building stones of Warren County are mostly quarried from the beds of the Gasper oolitic limestone. The beds vary in thickness from 10 to 22 feet, without seam or flaw. In color, the rock is ''Royal White,'' white, very light gray, gray, and dark gray. All varieties weather white, or nearly white. The stone is oolitic, fine grained, if less than .2 millimeters in diameter; medium grained, from .2 to .4 millimeters in diameter; coarse grained, more than .4 millimeters in diameter. The fracture sometimes crosses the oolites, and sometimes it goes around them, so that the oolites stand out conspicuously on the broken surface. In polished samples the contrast is strong between the pure white exterior of the oolite and the darker interior. Most of the oolites are round, but some of them are elongated. The stone has perfect rift and grain, and lends itself to the most delicate carving. When freshly quarried, it is somewhat stained

by bituminous substances, which completely evaporate upon exposure to the atmosphere. The seasoned stone, therefore, is white, or nearly white.



78. DIMENSION BLOCKS.

These blocks are at the cutting plant of the Bowling Green Quarries Company, Bowling Green, Warren County, Ky.

(1) *Green River Quarry.* This quarry is situated about 6 miles northwest of Bowling Green, the county seat of Warren County. Some of the beds are 20 feet in thickness, without seam or flaw. The length of the quarry is 500 feet. The breadth is approximately 500 feet. The stone has been quarried over the entire area now covered by waste material. A spur of the railroad carries the stone from the quarry to Barren River. It is then transported by barges to Bowling Green for manufacture.

In quarrying the stone channeling machines cut the vertical channels to the depth of the block desired, and gadding machines cut the horizontal channels. Therefore the blocks of limestone are cut in the quarry in whatever dimensions may be desired for shipment to the mill without the use of explosives. The huge blocks are lifted from the quarry floor by dericks and loaded on cars for shipment to Barren River.

At this quarry there is more of the thick bedded, oolitic limestone than there is in the other quarries around Bowling Green. It represents a rare opportunity to secure a most excellent building stone in large quantitics at reasonable prices. Since the stone lends itself readily to the most delicate carving, and weathers white, it is well adapted for monumental work.

79. POSTOFFICE, BOWLING GREEN, KY.

This Government Building was built of white crystalline limestone from the white limestone quarries near Bowling Green, Warren County, Ky.

There is at the Green River Quarry some 10 feet of overlying, thin bedded, dark gray, fossiliferous limestone, with the upper portion much decomposed, that has to be removed to gain access to the white, thick bedded building and monumental stone. For a detailed petrographic description of a microscopic slide from the Green River Quarry see Slide No. 2 in Chapter V.

(2) *White Stone Quarry.* This quarry is situated approximately 5 miles southwest of Bowling Green. The length of the quarry is 800 feet and the breadth is 500 feet. The thickness of the individual beds is 20 feet. Modern quarrying machinery is here installed, and the quarry products are shipped by a spur of the Louisville & Nashville Railroad to the main line, and then to Bowling Green for manufacture.

A part of the building stone obtained at the White Stone quarry is the typical white, oolitic, non-crystalline limestone. A part is a very fine grained, compact, birdseye limestone, and a part is a semi-crystalline, oolitic limestone. The calcium carbonate does not appear to be sufficiently recrystallized to class the product as a marble, mineralogically. Unfortunately, no microscopic slide from this quarry has been prepared for petrographic study.

80. CITIZENS NATIONAL BANK, BOWLING GREEN, KY.

This bank at Bowling Green, Warren County, Ky., was built of Bowling Green white oolitic limestone.

(3) *Knob Church Quarry.* This quarry is situated about 7 miles southwest of the City of Bowling Green, and in close proximity to the Knob Church. The length of the quarry is about 500 feet. The breadth of the quarry is about 150 feet. The quarry does not appear to have been worked to a depth exceeding 8 or 10 feet. There is but little overburden to be removed. Channeling machines do not appear to have been used, but explosives were used, and much good building stone

was wasted. The outline of the working face is markedly irregular, showing that little attention was paid to the rift of the stone.

81. FIRST BAPTIST CHURCH, BOWLING GREEN, KY.

The approach to the First Baptist Church, Bowling Green, Ky., was built of the white crystalline limestone from the white stone quarry, near Bowling Green, Warren County, Ky.

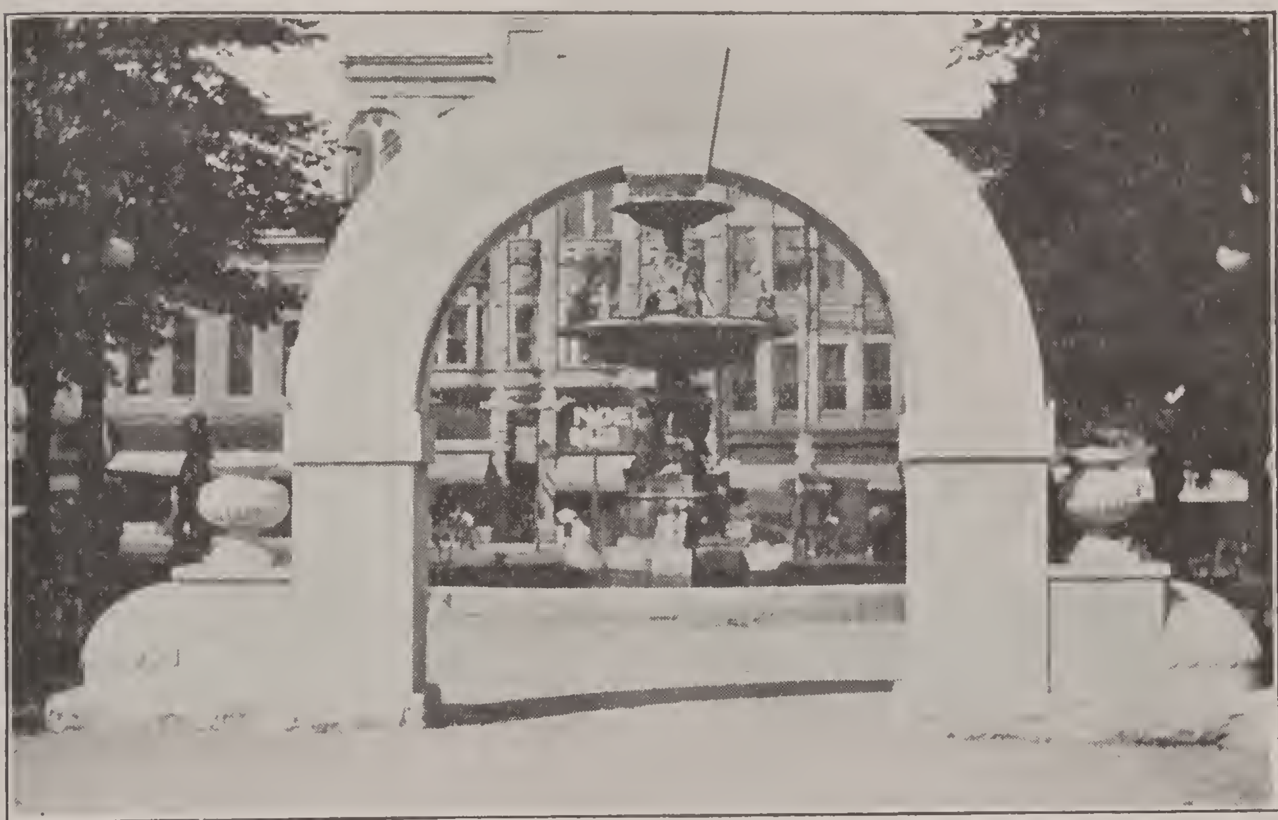
A part of the limestone at this quarry is light gray in color and banded. The alternating layers of different hues are very narrow. The stone is oolitic, and fine to medium grained. The banding on sample No. 3 on exhibition in the museum of the Kentucky Geological Survey is very pronounced when wet. The stone quarried here was removed by a spur of the Louisville & Nashville Railroad. This site furnishes a good opportunity for reopening the quarry for both building and monumental stone.

(4) *Bowling Green Whitehouse Quarry of Kentucky.* This quarry is situated at Memphis Junction on the Louisville & Nashville Railroad. The stone is here thick bedded, white, oolitic, and fine for building purposes. The product is used by the Louisville and Nashville Railroad.

(5) *Kissler and Rigelwood Quarry.* This quarry is situated about 4½ miles southwest of Bowling Green, and about one-half mile northeast of the White Stone quarry. The quarry is in the thick bedded, white, oolitic limestone. The product is controlled by the Louisville & Nashville Railroad. The limestone here dips 2 degrees to the west.

(6) *County Quarry.* This quarry is on the Nashville Pike, about 1½ miles south of Bowling Green. There is a crusher at this quarry with a capacity of 100 tons. The quarry is in the Ste. Genevieve limestone, and the product is used for road construction.

(7) *Jordan & Sons Quarry.* This quarry is situated on the Russellville Pike, about 3 miles southwest of Bowling Green. The quarry is in the Ste. Genevieve limestone, and the product is used for monumental work.



82. GATEWAY TO CITY PARK, BOWLING GREEN, KY.
This gateway was built of white crystalline limestone, Smallhouse quarry, near the Knob Church.

(8) *Rockfield Quarry.* This quarry is about 8 miles southwest of Bowling Green, and about one-half mile west of the Russellville Pike.

(9) *Stewarts Quarry.* This quarry is situated 9 miles southwest of Bowling Green, and about one-half mile west of

the Russellville Pike. The stone is shipped by a spur to the Memphis Branch of the Louisville & Nashville Railroad.

(10) *Smallhouse Quarry.* This quarry is situated in the Knob Church area, about 7 miles southwest of Bowling Green.

(11) *City Quarry.* This quarry is situated just outside the city limits, directly north of the city. This quarry is in the Ste. Genevieve limestone.

(12) *Underwood Quarry.* This quarry is located on both sides of the Richardsville Pike, about 3 miles north of Bowling Green. It furnished the stratified, bluish gray limestone from which the Methodist Church on State Street, Bowling Green, was erected. The quarry is now inactive.

83. STATE STREET METHODIST CHURCH.

This church is on State Street, Bowling Green, Warren County, Ky. The stone came from the Underwood quarry and shows well the value of the stone in church edifices.

(13) *Moultenburg Quarry.* This quarry is on the Morgantown Pike, $2\frac{1}{2}$ miles west of Bowling Green, with the actual quarry about 80 rods to the left of the pike.

(14, 15) *Victoria Limestone Company Quarries.* These quarries are situated near Slim Island, about 5 miles northwest of Bowling Green, on the north side of Barren River. The stone

was shipped to the river by rail. These quarries are now inactive. The stone is thick bedded, and fine for building purposes. The quarries can be reopened with very little expense. The stone for the Governor's Mansion at Frankfort, Ky., came from this quarry.

84. SLIM ISLAND QUARRY.
This cut shows an abandoned quarry near Slim Island, Warren County, Ky. It also shows the thickness of the beds.

(16, 17, 18) *N. P. Thomas Quarries.* These quarries are situated 7 miles northwest of Bowling Green on the farm of N. P. Thomas, now leased by J. E. Condra, and Mrs. A. G. W. Killow. The stone is of very good quality.

(19) *Caden Stone Company Quarry.* This quarry is situated on Gasper River, about 1 mile above where it empties into Barren River, and about 9 miles northwest of Bowling Green. The beds at this quarry dip 1½ degrees to the northwest. The stone is very good for building purposes and monumental work. The quarry has been in successful operation for over 50 years, and the product largely shipped to Evansville, Indiana, for manufacture.

(20) *Green Castle Quarry.* This quarry is on Barren River at the mouth of Lost Creek, 8 miles northwest of Bowling Green. The stone is shipped to Bowling Green by barges.

(21) This quarry is 12 miles northwest of Bowling Green on the head of Clay Lick Creek. It is on the west side of the Bowling Green and Woodbury Road. The stone is used in the construction of the pike. It is a coarse grained limestone that would make a good building stone.

(22) This quarry is situated in the extreme northern part of Warren County, 1½ miles east of Woodbury, Butler County. The quarry is on the west bank of Clay Lick Creek, in a yellowish brown sandstone of the Bee Springs formation of the Pennsylvanian system. The quarry opening is 100 feet in length, 50 feet in breadth, with height of working face 40 feet. The individual beds are from 6 to 18 inches in thickness, and slightly banded with iron stains.

The claims made for the white, oolitic limestones of Bowling Green are:

1. Beauty of color and uniformity of texture.
2. Strength.
3. Durability.
4. Ease of working.
5. Resistance to discoloring influences.
6. Resistance to action of heat and moisture.

The compressive strength of America's best marbles ranges between 11,000 and 16,000 pounds per square inch.

The Bowling Green white, oolitic limestone has been styled "The Aristocrat of all the limestones." Its beauty of color and uniformity of texture are especially noteworthy features. True it is that when the stone is first quarried it appears dingy and rather unpleasing, but when completely bleached by the evaporation of the occluded petroleum, it is a stone of great whiteness and remarkable beauty.

The strength of this stone is in excess of any weight that would be imposed upon any building stone by the usages of modern architecture. According to the compression tests made at the Watertown Arsenal, Mass., the resistance per square inch in three samples is 6,532 pounds, 7,009 pounds, and 6,746 pounds.

The durability of the stone is evidenced by the fact that some of the hearthstones and chimney caps erected more than a

century ago are perfectly intact, and show few, if any, evidences of disintegration.

Some of the buildings in Bowling Green were constructed of this stone more than 80 years ago, which still retain the original tool marks.

The Bowling Green white, oolitic limestone is worked with remarkable ease. This is due to its perfect rift and grain and its uniformity of texture. The stone readily admits of the finest carving, so that the most delicate capitols may be easily constructed. This is a decided advantage also in monumental work, where much carving is desired. The stone is said to split so uniformly that a curved surface of 100 degrees may be split without risk of the line of fracture crossing the curve.

The resistance of this stone to the destructive agents of the atmosphere is equal to that of the Bedford, Indiana, oolitic limestone, which is doubtless the best known and most popular uncrystallized limestone for constructional purposes in America.

It is true, however, that in the case of the Bowling Green stone some care must be exercised in the selection of the blocks for either constructional or monumental work. Occasionally there is present a small lens containing the sulphide of iron, probably pyrite, FeS_2, which inevitably leads to a discoloration of the stone, if not to actual cavities. What the writer has in mind can best be seen in one of the fluted columns at the main entrance to the Carnegie Library in Louisville, Ky. This difficulty can always be avoided by a judicious selection of dimension blocks. The writer has seen many buildings that have stood for at least 25 years exposed to all the destructive influences of the atmosphere without showing any discoloration due to iron content.

The product of all the quarries in the Bowling Green district is impregnated with oil. This renders the stone somewhat unpleasing in its effect when freshly quarried, but the oil rapidly bleaches out on the surface and leaves the stone a rich, creamy white color.

The Bowling Green white oolitic stone was awarded a gold medal at the World's Columbian Exposition, Chicago, 1893, and it received the highest award at the Louisiana Purchase Exposition, St. Louis, 1904.

Manufacture. The plant of the Bowling Green Quarries Company is situated just outside of the city limits on the north side of the city. The plant is equipped with modern machinery for cutting and dressing the stone. The company is equipped to meet the requirements of the most discriminating trade.

Some of the buildings that have been constructed entirely or in part of Bowling Green white, oolitic limestone are here given to show its wide industrial application:

Fluted columns in the front of the Administration Building, Potter College, Bowling Green, Ky.

Citizens National Bank, Bowling Green, Ky. The stone for this building was shipped from the quarries to St. Louis for cutting and reshipped to Bowling Green for construction.

Gateway to City Park, Bowling Green, Ky. White, crystalline, oolitic limestone. Smallhouse Quarry.

State Street Methodist Church, Bowling Green, Ky. Underwood Quarry.

United States Postoffice Building, Bowling Green, Ky.
Warren Deposit Bank, Bowling Green, Ky.
Warren County Courthouse, Bowling Green, Ky.
Saint Thomas Cathedral, Fifth Avenue, New York, N. Y.
The Hall of Records, Brooklyn, N. Y.
The Dime Savings Bank, Brooklyn, N. Y.
Church of Our Lady of Victory, Philadelphia, Pa.
Residence of Mr. Alfred E. Burke, Philadelphia, Pa.
Residence of Mr. A. M. Lothrop, Washington, D. C.
Residence of Mr. E. H. Everett, Washington, D. C.
Residence of Senator Joseph W. Bailey, Washington, D. C.
The Seelbach Hotel, Louisville, Ky.
The Christian Church, Louisville, Ky.
The Presbyterian Theological Seminary, Louisville, Ky.
Residence of Hon. John B. Daniel, Nashville, Tenn.
United States Custom House, Nashville, Tenn.
Carnegie Library, Nashville, Tenn.
Nashville Trust Co., Nashville, Tenn.
Stahlman Building, Nashville, Tenn.
United States Arsenal Buildings, Columbia, Tenn.
The Tennessee Trust Co., Memphis, Tenn.
North Memphis Savings Bank, Memphis, Tenn.
Residence of Col. C. B. Galloway, Memphis, Tenn.
Atlanta University Buildings, Atlanta, Ga.
Chamber of Commerce, Atlanta, Ga.
Odd Fellows' Temple, Atlanta, Ga.
St. Boniface School and Church, Evansville, Ind.
St. Mary's School and Parsonage, Evansville, Ind.

Ohio Valley Bank Building, Henderson, Ky.
Jewish Synagogue, Henderson, Ky.
United States Government Building, Lexington, Ky.
Broadway Christian Church, Lexington, Ky.
United States Government Building, Paducah, Ky.
Grace Episcopal Church, Paducah, Ky.
Citizens' Savings Bank, Paducah, Ky.
Knights of Pythias Hall, Clarksville, Tenn.
United States Government Building, Jackson, Tenn.
Illinois Central R. R. Offices, Jackson, Tenn.
Tennessee State Bank Building, Humboldt, Tenn.
The Polytechnic Institute, Auburn, Ala.
Church of the Holy Innocents, Monte Sano, Ala.
Bennett Building, Peoria, Ill.
United States Government Building, Carmi, Ill.
United States Government Building, Jackson, Miss.
United States Government Building, Gulfport, Miss.
United States Government Building, Pensacola, Fla.
United States Government Building, Jacksonville, Fla.
Saint John's Cathedral, Jacksonville, Fla.

Conclusions

The oolitic limestones of Warren County, known as the Bowling Green Stone, are fully the equal of the oolitic limestones of Bedford, Laurence County, Indiana. The two oolites closely resemble each other in color, texture, chemical composition, durability, and the case with which they lend themselves to quarrying, dressing and carving. When the quarry water is in the stone it can be easily and most delicately carved, but upon evaporation of the quarry water the stone in each case hardens. The Bedford stone needs to be set in the wall in such a position that the pressure of the supernatant rock is at right angles to the plane of bedding. The Bowling Green stone can be set in any position in the wall. The Bowling Green stone should be thoroughly seasoned before shipment from the mill yard to the place of consumption.

Number of County.	Name of County.	Number of Quarries in County.
76	Adair	3
77	Allen	2
78	Barren	9
79	Breckinridge	5
80	Caldwell	6
81	Casey	0
82	Christian	4
83	Crittenden	2
84	Cumberland	1
85	Edmonson	1
86	Grayson	12
87	Green	1
88	Hardin	6
89	Hart	6
90	Laurel	3
91	Livingston	3
92	Logan	6
93	Lyon	8
94	Meade	3
95	Metcalfe	1
96	Monroe	1
97	Russell	1
98	Simpson	2
99	Taylor	1
100	Todd	5
101	Trigg	4
102	Warren	22
Total number of quarries		118

CHAPTER IX

THE WESTERN COAL FIELD

The western coal field embraces a smaller number of counties than any other distinct geographic Province of the State, with the single exception of the Jackson Purchase. The area is situated in the western part of Kentucky and lies between the Ohio River on the north and the Mississippian terranes on the south. Grayson and Edmonson counties were included in the preceding chapter for they are not strictly considered western coal measure counties. Their terranes, however, are about equally divided between the Mississippian and Pennsylvanian systems.

The terranes described in this chapter are predominantly Pennsylvanian. In a few instances tongues of the Mississippian system will be found extending into the Pennsylvanian formations. The area is one teeming with the coal industry, and but few quarries in the Pennsylvanian sandstones have been opened. The chapter will of necessity be brief.

Butler County

The terranes of Butler County belong to the Mississippian and the Pennsylvanian systems. The Mississippian formations cover quite an extensive area in the southern part of the county. These terranes belong to the Chester series. The remainder of the county is covered by the Pennsylvanian Coal Measures outcrop.

Since the thick bedded Gasper oolitic limestone furnishes so many large quarries which are situated only a few miles east of the southern portion of Butler County, building stone quarries can be found in this county in the Mississippian formation. It is possible that quarries have been opened up for stone for foundation work in Morgantown, the county seat, but the author has no definite knowledge of the existence of such quarries.

According to G. T. Phelps, County Judge of Butler County, there is an abundance of good sandstone for building purposes within the county. Also in the southwest part of the county there is a fine grade of limestone suitable for building purposes and road construction.

Daviess County

The terranes of Daviess County are all Pennsylvanian in age. The building stones, if any exist, are therefore sandstones. According to J. S. Hudnall, Assistant Geologist of Kentucky, there are no quarries in this sandstone series in Daviess County. Owensboro on the Ohio River is the county seat.

Hancock County

The terranes of Hancock County belong to the Mississippian and the Pennsylvanian systems. The Mississippian formations are confined to a narrow strip in the extreme eastern portion. The Pennsylvanian system covers the remainder of the county. The limestones of the extreme eastern portion should furnish building stone for local use.

(1) *Hawesville Quarry.* A quarry was reported near Hawesville, the county seat of Hancock County. The quarry was said to be in sandstone, and the stone used for foundation work and curbing. The quarry was not visited.

Henderson County

All the terranes of Henderson County belong to the Pennsylvanian system. The outcrops are therefore sandstones. According to J. S. Hudnall, Assistant Geologist of Kentucky, there are no quarries in Henderson County. Henderson, on the Ohio River, is the county seat.

According to Spalding Trafton, Postmaster, there has been no stone quarried in this county for building purposes or for the construction of sidewalks. Some years ago rock was obtained and crushed at a point near Smith's Mill, and used for a time for macadamizing roads. This, however, did not prove profitable and was abandoned.

Hopkins County

All the terranes of Hopkins County belong to the Pennsylvanian system. Most of the quarries are situated in fine to medium grained sandstones. Three of them are in the bluish gray compact limestone.

(1) *Major M. K. Gordon Quarry.* This quarry is situated just east of the little lake on Ebenezer Street six blocks west of

the courthouse at Madisonville, the county seat. The quarry is in a bluish gray limestone and the product used for foundation work, bridges, culverts, and curbing.

(2) *Browning Springs Quarry.* This quarry is situated at the west end of Arch Street, five blocks west of the courthouse. This quarry is in the bluish gray limestone.

(3) *Sunlight Coal Company Quarry.* This quarry is situated in the grapevine country three miles southeast of Madisonville. The quarry is in the bluish gray limestone.

(4) *Drakes Creek Quarry.* This quarry is situated 2½ miles southeast of Nortonville on the Louisville & Nashville Railroad. The quarry is in a bluish gray sandstone.

(5) *Oak Hill Quarry.* This quarry is one mile north of Nortonville on the Louisville & Nashville Railroad. The quarry is in sandstone. The individual beds are fifteen feet in thickness. The stone has been used for pillars under houses, foundation work, abutments, bridges, culverts, curbing, etc.

(6) *Marion Page Quarry.* This quarry is situated 2 miles south of Nortonville on the Louisville & Nashville Railroad. The quarry is operated by the Rodgers Brothers. It is in sandstone.

(7) *Grampian Hills Quarry.* Some old abandoned sandstone quarries were found in the Grampian Hills near Madisonville. The stone for the residence of William C. Morton, Architect, was quarried here in 1872. The stone in the Methodist Church at Madisonville came from the Grampian Hills. The stone in the base course of the Presbyterian Church came from the same quarries. The stone was quarried in 1840. It has been through one fire and used twice. The top step of approach to this church came from the old courthouse and was quarried over 90 years ago. The Kentucky Bank and Trust Company was erected in 1901 on a sandstone foundation. The stone came from the sandstone of the old hotel erected in 1850. The coke ovens at Earlington are all built of local sandstone.

(8) *Dawson Springs Quarry.* This quarry is about ½ mile south of Dawson Springs and is inactive. It furnished the sandstone for the foundation of an old mill near the quarry more than 60 years ago, and also the foundations for many structures around Dawson Springs.

McLean County

All the terranes of McLean County belong to the Pennsylvanian system. Therefore the building stones are essentially sandstones. There are beds of massive sandstone along Green River. Only one quarry was reported in McLean County. The quarry was said to be near Calhoun, the county seat, and the stone used for foundation work. It was not visited.

Muhlenberg County

The terranes of Muhlenberg County belong to the Mississippian system. The Mississippian terranes are confined to the southern part of the county. Both the Waverlian and the Mammoth Cave limestone series are absent. The Chester series occupies only a small area.

The outcrops containing stone suitable for building purposes should contain both limestones and sandstones. The Pennsylvanian sandstones have furnished some very good sandstone for constructional work. Greenville is the county seat of Muhlenberg County.

(1) *Mack Ferguson Quarry.* This quarry is situated ½ mile west of South Carrollton. The quarry is in limestone. The stone was quarried for road construction and burned into lime for both building and agricultural purposes.

(2) *Mack Ferguson Quarry.* This quarry is situated ½ mile north of South Carrollton. In this quarry there is a buff sandstone on the top varying from 6 to 10 feet in thickness. The middle layer consists of a gray sandstone 4 feet in thickness. The bottom of the quarry contains 20 feet of fine grained, even textured blue sandstone.

When this quarry was active the stone was used by the Illinois Central and the Louisville & Nashville Railroads in piers and abutments for bridges. It was shipped to Georgia and Alabama for building purposes. In 1910 it was shipped to New York City for use in the interior of the Cathedral of St. John the Divine.

The John Omar Company had a mill for cutting, dressing, polishing, and sculpturing the stone. More than 500 carloads of stone were shipped from South Carrollton.

(3) *Mack Ferguson Quarry.* This quarry is near the large quarry described as No. 2. It contains the same varieties of sandstone as No. 2, but has never been as extensively worked.

(4) *Mack Ferguson Quarry.* This quarry is situated within the corporation limits on the east side of the town. The thick-bedded sandstone here is very durable.

(5) *Ernest Purdy Quarry.* This quarry is situated on the east bank of Green River. This quarry has been inactive for several years.

(6) *J. F. Wolcott Quarry.* This quarry is near the bank of Green River just outside the city limits. The stone from this quarry has been used for underpinnings, foundations and outside stone chimneys. Some of the stone in a stone cellar which was built more than 60 years ago with stone from this quarry still shows the tool marks as fresh as when the stone was cut. Some of the stone in the outside stone chimneys now more than 75 years old still retain the tool marks. Most of the chimneys came from the buff bed.

Ohio County

The terranes of Ohio County belong to the Mississippian and Pennsylvanian systems. The Mississippian formations are confined to a small area in the eastern part of the county. This area in part extends in an east and west direction bordering Rough River both on the north and the south; in part on both sides of Caney Creek, a tributary to Rough River from the south, and in part on both sides of a tributary to Rough River from the north. The Mississippian terranes belong to the Chester series. The remainder of the outcrops which cover nearly the entire county belong to the Western Coal Measures of Pennsylvanian age.

Some limestones should be found in the Chester series that could furnish building stone for local use around Hartford, the county seat, but the author has not been able to ascertain that any quarries have been opened in the Chester series.

The Pennsylvanian sandstones in several counties have furnished building stone for both local use in Muhlenberg County, and shipment outside of the State; and it is not regarded as impossible that commercial sandstones exist in this county.

Union County

All the terranes of Union County belong to the Pennsylvanian system. The building stones should be sandstones. A little sandstone was reported to have been quarried near Morganfield, the county seat, for foundation work. There are, however, massive, thick bedded sandstones along the Tradewater River in the southern part of the county. These sandstones should furnish some good quarries.

Webster County

All the terranes of Webster County belong to the Pennsylvanian system. The building stone possibilities are in both the limestone and the sandstone members, but no quarries appear to have furnished foundation stone for Dixon, the county seat.

According to G. E. Vaughn, County Judge of Webster County, there are splendid ledges of limestone near Providence, and also an abundance of thick bedded sandstones along the Tradewater River in the southwestern portion of the county, but no quarries are in operation in these formations.

Number of County.	Name of County.	Number of Quarries in County.
103	Butler	0
104	Daviess	0
105	Hancock	1
106	Henderson	0
107	Hopkins	8
108	McLean	1
109	Muhlenberg	6
110	Ohio	0
111	Union	1
112	Webster	0
Total number of quarries		17

CHAPTER X

THE JACKSON PURCHASE

The Jackson Purchase embraces a smaller number of counties than any other geographic province of the State. It is situated in the extreme southwestern corner of Kentucky. Three of its boundary lines are navigable rivers. Its boundary lines are, on the north the Ohio River; on the east the Tennessee River; on the south the State of Tennessee; on the west the Mississippi River. Its terranes are represented by the youngest rocks of the State. Nearly all of them belong to the Cretaceous and Quarternary systems. They are largely unconsolidated sediments. Where consolidation has taken place the cementing material is largely the oxides and hydrous oxides of iron. In general where the Mississippian outcrops in the eastern part of the Jackson Purchase the altitudes are low and the region swampy. It cannot therefore be expected that much good building stone will ever be quarried within this geographic province.

There is, however, another phase of the problem that may be mentioned. There are large deposits of high grade gravel in the Rivers and Creeks of the Jackson Purchase that are extensively used in the manufacture of concrete for constructional purposes and for permanent roads. These gravels when carefully screened could be used in the exterior adornment of stucco structures to a very good advantage.

Ballard County

All the terranes of Ballard County belong to the Quarternary system. There are no quarries within the county, but gravel for concrete work has been used from the Ohio River. Wickliffe, on the Mississippi River, is the county seat.

Calloway County

The terranes of Calloway County belong to the Mississippian, Cretaceous and Quarternary systems. The Mississippian formations are represented by the Mammoth Cave limestone series which occur as a narrow belt in the eastern part of the county. However, there is a narrow belt of the Quarternary formations between the limestone and the Tennessee River. The

Cretaceous formations are also in the eastern portion, but between the Mississippian and the Cretaceous there is generally a strip of the Quarternary outcrops. The Quarternary formations cover the entire western two-thirds of the county. Murray is the county seat.

According to G. L. Laughton, County Judge of Calloway County, there are no quarries within the county. The Government roads are made of gravel from gravel pits on the various creeks.

According to Prof. D. H. Davis, Assistant Geologist, Kentucky Geological Survey, the sandstones and conglomerates of the Jackson Purchase are all too friable for use as building stone, but Davis advises that there are outcrops of limestone on the road from New Concord to Patterson's Store on the Tennessee River, and about 2 miles west of the store, that are worthy of careful investigation as to their possible use as building stone within the Jackson Purchase.

Carlisle County

All the terranes of Carlisle County belong to the Quarternary system. There are no known quarries within the county. Bardwell is the county seat.

Fulton County

All the terranes of Fulton County belong to the Quarternary system. According to Charles D. Nugent, County Judge of Fulton County, there are no quarries within the county. All the gravel and crushed rock used within the county has been shipped in from other localities. Hickman, on the Mississippi River, is the county seat.

Graves County

All the terranes of Graves County belong to the Quarternary system. According to J. W. Munroe, County Judge of Graves County, there are no quarries within the county. There are, however, a number of gravel pits possessing the same character as the Paducah gravel which, when put on the road in sufficient quantity, makes a very excellent hard surface road.

Hickman County

All the terranes of Hickman County belong to the Quarternary system. According to J. J. Flatt, County Judge of Hickman County, there was once a sandstone quarry within the county, but the stone was long since exhausted. There are, however, some gravel deposits that are not easy of access, and consequently are not being worked at the present time. Clinton is the county seat.

McCracken County

The terranes of McCracken County belong to the Cretaceous and Quarternary systems. The Cretaceous outcrops are confined to a very narrow belt in the northeastern part of the county, extending in a southeasterly direction from Paducah, the county seat, along the south bank of the Tennessee River, as far to the southeast as the Marshall County line.

85. POSTOFFICE, PADUCAH, KY.
This Government Building at Paducah, McCracken County, Ky., shows the combined effect of both Bowling Green white oolitic limestone and Bedford, Indiana, oolitic limestone in the same structure.

According to J. W. Lang, County Judge of McCracken County, there are no quarries within the county, but plenty of gravel along the Ohio River for constructional work.

Marshall County

The terranes of Marshall County belong to the Mississippian, Cretaceous and Quarternary systems. The Mississippian outcrops belong to the Mammoth Cave limestone series. These are confined to the eastern part of the county, but there is a narrow belt of the Quarternary outcrops between the limestone and the Tennessee River. The Cretaceous outcrops fall into three isolated areas. (1) In the northwest corner of the county along the south side of the Tennessee River. (2) A small area just north of Briensburg. (3) A long, narrow area extending in a northwesterly and southeasterly direction just east of Benton, the county seat. No quarries are known to exist within the county, but the Mammoth Cave limestone series may possibly contain beds of limestone that could be used commercially.

Number of County.	Name of County.	Number of Quarries in County.
113	Ballard	0
114	Calloway	0
115	Carlisle	0
116	Fulton	0
117	Graves	0
118	Hickman	0
119	McCracken	0
120	Marshall	0
		0
	Total number of quarries for State	610

CHAPTER XI

ANALYSES OF LIMESTONES, MARBLES AND SANDSTONES

The object in presenting the analyses of many limestones, marbles and sandstones in a separate chapter in alphabetical order by counties is to show that the State of Kentucky has within its borders in widely distributed areas a great supply of building stone whose chemical composition falls well within the range of structural stone. The chemical composition of a building stone is often a guide to its suitability for constructional or monumental work.

The analyses furthermore will reveal the location of many of the purest sedimentary rocks and enable architects, engineers, contractors, Chambers of Commerce and churches to select more wisely desirable stone for their superstructures.

A careful study of the analyses reveals several important facts. The calcareous rocks may be divided into five groups as follows:

1. Pure limestones.
2. Magnesian limestones.
3. Siliceous limestones.
4. Dolomites.
5. Marbles.

The siliceous rocks or sandstones have clayey matter or calcium carbonate as the principal cementing material for the sand grains. The iron content is low, or wanting, in most cases. It may reach its maximum in some of the crinoidal limestones but even here at times the iron content is reduced to a negligible factor.

The analyses as they appear in this chapter were made by, or under the direction of, Dr. Robert Peter and Dr. A. M. Peter, Directors of the State Experimental Station, Lexington, Kentucky. Wherever an exception to this rule appears the name of the analyst is given provided the name is known.

ANDERSON COUNTY

March 13, 1911.

Laboratory No. G-3334.—"Limestone from Kentucky River cliffs at Tyrone, Anderson County, Ky. Middle of the Tyrone formation. Sampled by F. J. Fohs. Brought by T. B. Ripy, Jr., Lawrenceburg, Ky."

A compact olive-gray limestone containing some cavities of calcite, possessing a marked conchoidal fracture. Some pieces weathered on the surface.

Specific gravity, 2.71.

Analysis of the air-dried sample.	Per cent.
Moisture, at 100° C.	.09
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.98
Silica, SiO_2	2.28
Alumina, Al_2O_3	.82
Ferric oxid, Fe_2O_3	trace
Ferrous oxid, FeO	.25
Calcium oxid, CaO	50.87
Magnesium oxid, MgO	2.87
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Total	100.16
Calcium carbonate, $CaCO_3$	90.71
Equivalent to the calcium oxid.	
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	6.03

(Analysis by J. S. McHargue.)

BARREN COUNTY

Laboratory No. 61757.—Sample from the Harvey Quarry near Glasgow. Sent by J. O. Horning, County Agent. The sample was about a pound lump of neutral-gray, crystalline limestone which gave by analysis:

	Per cent.
Calcium carbonate	92.1
Magnesium carbonate	0.4
Impurities by difference	7.5
Total	100.00

92.1% of calcium carbonate is equivalent of 51.6% of calcium oxide or pure lime. 0.4% of magnesium carbonate is equivalent to 0.2% of magnesium oxide or pure magnesia. This represents a very good building stone; a good road building rock; and, also, it is agricultural.

Laboratory No. 6175V.—Sample from the Matthews Quarry at Templehill, Barren County. Sent by J. O. Horning, County Agent. The sample was about a pound lump of dark-neutral gray colored, crystalline limestone, which gave by analysis:

	Per cent.
Calcium carbonate	93.6
Magnesium carbonate	0.4
Impurities by difference	6.0
Total	100.0

93.6% of calcium carbonate is equivalent to 52.5% of calcium oxide or pure lime. 0.4% of magnesium carbonate is equivalent to 0.2% or magnesium oxide or pure magnesia.

This sample represents a very good building stone; a good road building rock; and, also, it is agricultural.

From Kentucky Geological Survey Reports, Vol. A, part 1, pages 16-17.

No. 1421.—Limestone. "Oolitic Limestone. Upper layers of upper sub-carboniferous limestone. Glasgow Junction, Barren County. Collected by Prof. N. S. Shaler."

A compact, nearly white, fine oolitic limestone, with a ferruginous stain on the exposed surfaces probably derived from the superincumbent soil.

Composition of this Barren County limestone, dried at 212° F.:

Specific gravity, 2.678.

	Per cent.
Lime, carbonate	98.050
Magnesia, carbonate	.363
Alumina, and iron and manganese oxide	.511
Phosphoric acid	.051
Sulphuric acid	.260
Potash	.115
Soda	.327
Silica and insoluble silicates	1.060
Total	100.737
Percentage of lime	50.428
Percentage of phosphorus	.022
Percentage of sulfur	.104
Total calcium and magnesium carbonates	98.413

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. A, part 1, pages 16-17.

No. 1422.—Limestone (compact). "Upper sub-carboniferous limestone. Glasgow Junction. Collected by N. S. Shaler."

A light-gray, fine granular, or compact limestone, which might be a good lithographic stone but for the presence of some imbedded fossils and minute specks or iron peroxide.

Composition of this Barren County limestone, dried at 212° F.: Specific gravity, 2.721.

	Per cent.
Lime, carbonate	77.550
Magnesia, carbonate	13.314
Alumina, and iron and manganese oxide	2.680
Phosphoric acid	.051
Sulphuric acid	.192
Potash	.154
Soda	.188
Silica and insoluble silicates	6.060
Total	100.189
Percentage of lime	43.428
Percentage of phosphorus	.022
Percentage of sulfur	.077
Total calcium and magnesium carbonates	90.864

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. A, part 1, pages 16-17.

No. 1423.—Limestone. Labeled "Lithographic Stone; below the building stone. Upper sub-carboniferous limestone. Glasgow Junction. Collected by Prof. N. S. Shaler."

A light-gray, compact, or very fine granular rock, which might be a perfect lithographic stone but for the minute imbedded fossils and the small occasional specks of iron peroxide, etc., which it contains. Some layers, however, are reported measurably free from these imperfections, and found to be good enough, on actual trial, for some ordinary lithographic purposes.

Composition of this Barren County limestone, dried at 212° F.: Specific gravity, 2.689.

	Per cent.
Lime, carbonate	82.960
Magnesia, carbonate	7.655
Alumina, and iron and manganese oxide	2.680
Phosphoric acid	.115
Sulphuric acid	.260
Potash	.135
Soda	.156
Silica and insoluble silicates	6.160
Total	100.121
Percentage of lime	46.457
Percentage of phosphorus	.050
Percentage of sulfur	.104
Total calcium and magnesium carbonates	90.615

(Analysis by Dr. Robert Peter.)

BOURBON COUNTY

From Kentucky Geological Survey Reports, Vol. A, Part 1, page 155.

No. 1638.—"Limestone (magnesian). From Cane Ridge; five miles east of Paris. Used for the foundation of the Bourbon County Courthouse at Paris. Sent by Mr. James Stevenson."

A somewhat porous, fossiliferous, ferruginous, magnesian limestone, of a light gray-buff color, containing small specks of hydrated oxide of iron. Specific gravity=2.58 to 2.60 (in the lump).

Composition, dried at 212° F.

	Per cent.
Lime carbonate	79.140*
Magnesia carbonate	11.826†
Alumina	.380
Iron peroxide	5.510
Phosphoric acid	.511
Sulphuric acid	.240
Potash	.231
Soda	.252
Soluble silica	.110
Insoluble silica	1.160
Loss	.640
Total	100.000
Total calcium and magnesium carbonates	90.966

*Equivalent to 5.371% magnesia. †Equivalent to 44.318% lime.

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 3, O. S,. page 223.

No. 578.—Limestone. Labeled "Crystalline lime-rock, quarry below the woods pasture, on Wm. Buckner's land, Cane Ridge, Bourbon County, Kentucky. Lower Silurian formation."

A limestone which is principally made up of large, pure, crystalline grains, with some little ochreous oxide of iron in spots throughout it; no fossils apparent in the specimen examined; weathered surface brownish.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	97.540*
Carbonate of magnesia	.699
Alumina, and oxides of iron and manganese	.287
Phosphoric acid	.093
Sulphuric acid	.180
Potash	.065
Soda	.206
Insoluble silicates	1.446
Total	100.516
Total calcium and magnesium carbonates	98.239

*Equivalent to 53.735% lime.

(Analysis by Dr. Robert Peter.)

BRACKEN COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 84.

No. 825.—Limestone. Labeled "Encrinital Limestone from near Augusta, Bracken County, Kentucky, where the virgin tobacco soil was collected. Lower Silurian formation."

A coarse-granular, gray limestone; on the weathered surfaces appearing to be almost entirely made up of small entrochites, with a few fragments of Chaetetes lycoperdon, etc.

Dried at 212° F., it gave up 0.30 per cent of moisture.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	91.040*
Carbonate of magnesia	3.678
Alumina and oxides of iron and manganese	1.660
Phosphoric acid	.182
Sulphuric acid	.269
Potash	.200
Soda	.148
Siliceous residuum	2.880
Total	100.057
Total calcium and magnesium carbonates	94.718

*Equivalent to 51.084% lime.

(Analysis by Dr. Robert Peter.)

BRECKINRIDGE COUNTY

Oolitic limestone from the Webster Stone Company, Irvington, Breckinridge County, Ky.

Analysis of the air-dry sample.	Per cent.
Moisture	0.000
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.652
Silica, SiO_2	.380
Alumina, Al_2O_3	.040
Ferric oxid, Fe_2O_3	.086
Ferrous oxid, FeO	0.000
Calcium oxid, CaO	55.540
Magnesium oxid, MgO	.300
Phosphorus pentoxid, P_2O_5	.002
Sulfur trioxid, SO_3	0.000
Titanium dioxid, TiO_2	0.000
Total	100.000

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	99.11
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	.38
Total calcium and magnesium carbonates	99.49

(Analysis by the chemist of the Ashland Iron and Mining Company, Ashland, Ky., Oct. 14, 1913.)

BULLITT COUNTY

From Kentucky Geological Survey Reports, Vol. 2, O. S., page 144.

No. 496.—Sandstone. Labeled "Building Stone, Knob at Bullitt's Lick, Bullitt County, Kentucky." (Sub-carboniferous Formation.)

A rather soft, fine-grained, buff-gray sandstone; adhering slightly to the tongue; exhibiting, under the lens, minute scales of mica; composed of fine-grained sand, united by an argillaceous cement.

Specific gravity, 2.427.

Composition, dried at 212° F.

	Per cent.
Sand and insoluble silicates	93.68
Alumina and oxides of iron and manganese	3.95
Carbonate of magnesia	.84
Carbonate of lime	trace
Potash	.21
Soda	.59
Sulphuric acid and loss	.73
Total	100.00

The air-dried rock lost .30 per cent of moisture, at 212° F.
(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 2, O. S., page 145.

No. 498.—Sandstone. Labeled "Building Stone, seventy feet above the (not given) shale, Bellemont Furnace, Bullitt County, Ky." (Subcarboniferous Sandstone Formation.)

A dirty buff-colored, fine-grained sandstone; adhering slightly to the tongue; resembling the preceding in structure.

Specific gravity, 2.453.

Composition, dried at 212° F.

	Per cent.
Sand and insoluble silicates	94.75
Alumina, and oxides of iron and manganese	3.48
Lime	.16
Magnesia	.70
Potash	.96
Soda	.10
Sulphuric acid	trace
Total	100.15

(Analysis by Dr. Robert Peter.)

CALDWELL COUNTY

From Kentucky Geological Survey Reports, Vol. A, Part 2, page 274.

No. 2460(b).—Oolitic Limestone. "Ten to twelve feet thick; from McElpatrick's Quarry, four miles east of Princeton, Caldwell County. Collected by R. H. Loughridge, November, 1884."

A light-buff-gray oolitic limestone, containing occasional small crystals of calc. spar and minute cavities stained with hydrated ferric oxid. Scarcely adheres to the tongue, but absorbs some water.

Composition (Air-dried).

	Per cent.
Lime carbonate	97.64*
Magnesia carbonate	1.18
Iron peroxide and trace of phosphoric acid	.28
Silicious residue	1.16
Total	100.26
Total calcium and magnesium carbonates	98.82

*Equivalent to 54.678% of lime.

(Analysis by Dr. Robert Peter.)

CARTER COUNTY

March 22, 1908.

Laboratory No. G-2847.—Limestone labeled "Quarry at Highland, from J. P. Nelson, C. & O. R. R., Lexington, Ky." A block of bluish-gray, nearly white, massive stone, about 30 lbs.

Analysis of the air-dry sample.	Per cent.
Moisture	.04
Ignition (carbon dioxid, organic matter, combined water, etc.)	34.30
Silica, SiO_2	20.06
Alumina, Al_2O_3	4.48
Ferric oxid, Fe_2O_3	2.88
Calcium oxid, CaO	28.00
Magnesium oxid, MgO	10.17
Phosphorus pentoxid, P_2O_5	trace
Total	99.93
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	50.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	21.36

(Analysis by J. S. McHargue.)

March 23, 1908.

Laboratory No. G-2848.—Limestone labeled "Quarry at Limestone, from J. P. Nelson, C. & O. R. R., Lexington, Ky." Sample, a block of hard, light buff colored limestone with conchoidal fracture and having small veins and crystals of calcite.

Analysis of the air-dry sample.	Per cent.
Moisture	.05
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.71
Silica, SiO_2	4.94
Alumina, Al_2O_3	1.22
Ferric oxid, Fe_2O_3	.48
Calcium oxid, CaO	51.80
Magnesium oxid, MgO	.76
Phosphorus pentoxid, P_2O_5	trace
Total	99.96
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	92.52
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.60

(Analysis by J. S. McHargue.)

March 23, 1908.

Laboratory No. G-2849.—Limestone labeled "Quarry on north side of track just west of Tygart. From J. P. Nelson, C. & O. R. R., Lexington, Ky." Sample, a block of light brownish-gray, compact limestone containing calcite crystals.

Analysis of the air-dry sample.	Per cent.
Moisture	.05
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.15
Silica, SiO_2	1.64
Alumina, Al_2O_3	.38
Ferric oxid, Fe_2O_3	.48
Calcium oxid, CaO	54.88
Magnesium oxid, MgO	.32
Phosphorus pentoxid, P_2O_5	trace
Total	99.90
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	97.10
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	.67

(Analysis by J. S. McHargue.)

From Kentucky Geological Survey Reports, Vol. A, Part 2, page 182.

No. 2290.—Limestone: "Just above the Limestone iron ore and under the plastic clay. Willard, Carter County. Collected by A. R. Crandall. Received July 9, 1883."

A compact limestone of a cream color, or very light buff, nearly white. Hardness=3.5. Fracture flat conchoidal. Does not adhere to the tongue.

Composition (Air-dried).

	Per cent.
Lime carbonate	96.380*
Magnesia carbonate	1.135
Alumina and iron oxid	.980
Phosphoric acid, P_2O_5	trace
Manganese brown oxid	.480†
Silica and silicates	.380
Moisture and loss	.645
Total	100.000
Total calcium and magnesium carbonates	97.515

*Equivalent to 53.973% of lime.
†Equivalent to 0.953% manganese carbonate.

(Analysis by Dr. Robert Peter.)

CLARK COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 114-5.

No. 876.—Magnesian Limestone. Labeled "Building Stone; quarry mouth of Lower Howard's Creek, Clark County, Ky. Lower Silurian formation."

A dull, light-buff, fine-granular rock; resembling that from Grimes' quarry in Fayette County. Specific gravity, 2.735.

Dried, in powder, at 212° F., it lost only 0.30 per cent of moisture.

Composition dried at 212° F.

	Per cent.
Carbonate of lime	60.640*
Carbonate of magnesia	32.500†
Alumina, and oxides of iron and manganese	.580
Phosphoric acid	207
Sulfuric acid	.124
Potash	.374
Soda	.250
Silex and insoluble silicates	3.520
Moisture and loss	1.805
Total	100.000
Total calcium and magnesium carbonates	93.140

*Equivalent to 34.028% lime.
†Equivalent to 15.404% magnesia.

(Analysis by Dr. Robert Peter.)

May 28, 1908.

Laboratory No. G-2868.—Limestone labeled "Second big cut west of Hornback curve, west of Indian Fields, 2½ miles. From lower 20 ft. of middle Richmond section at second big cut west of Hornback curve. Collected by A. F. Foerste, March 21, 1907. This is the fresh limestone interbedded in the lower part of the middle Richmond. The same limestone occurs also farther up but is badly weathered."

Analysis of the air-dried sample.	Per cent.
Moisture	.03
Ignition (carbon dioxid, organic matter combined water, etc.)	43.04
Silica, SiO_2	4.50
Alumina, Al_2O_3	2.78
Ferric oxid, Fe_2O_3	3.08
Calcium oxid, CaO	30.20
Magnesium oxid, MgO	16.36
Phosphoric acid, P_2O_5	.14
Sulfur trioxid, SO_3	trace
Total	100.13
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	53.93
Magnesium carbonate, $MgCO_3$, equivalent to to the magnesium oxid	34.36

(Analysis by J. S. McHargue.)

CRITTENDEN COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 123-4.

No. 899.—Sandstone. Labeled "Hearthstone, (best) found two miles from Crittenden Furnace, Crittenden County, Ky."

A light-salmon-colored sandstone, so friable as to be easily crushed in the fingers. Under the lens the clear quartz grains do not appear to be united by any cement. Some small black specks and a little oxide of iron give the color to it.

Composition, etc., dried at 212° F.

	Per cent.
Sand and insoluble silicates	99.080
Alumina and oxides of iron and manganese	.080
Lime	trace
Magnesia	.360
Phosphoric acid	trace
Sulphuric acid	.063
Potash	.386
Soda	.121
Water expelled at a red heat	.300
Total	100.390

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 129-30.

No. 916.—Sandstone. Labeled "Sandstone used for the bosh and inner wall, at Hurrican Furnace, Crittenden County, Ky. Found two miles from the furnace." A moderately firm, fine-grained sandstone; colored more or less with oxide of iron, in bands.

No. 918.—Sandstone. Labeled "Hearthstone, (superior) from the same locality as the preceding." Firmer and coarser-grained than the preceding; containing small rounded quartz pebbles, and peroxide of iron in spots.

Composition of these two sandstones, dried at 212° F.

	No. 916	No. 918
Sand and insoluble silicates	97.400	98.640
Alumina, and oxides of iron and manganese	.980	.580
Lime	trace	trace
Magnesia	.566	.266
Phosphoric acid	trace	trace
Sulphuric acid	trace	trace
Potash	.213	.212
Soda	.156	.028
Loss, and water expelled at red heat	.685	.400
Total	100.000	100.126
Moisture, lost at 212° F.	0.20	0.40

(Analysis by Dr. Robert Peter.)

EDMONSON COUNTY

December 4, 1907.

Laboratory No. G-2814.—Limestone from exposure No. 5 in cliffs of Green River at Brownsville, Ky., taken about 60 ft. above the river. Light gray to nearly white, hard limestone. Some layers oolitic.

Analysis of the air-dried sample.	Per cent.
Moisture	.10
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.85
Silica, SiO_2	1.90
Alumina, Al_2O_3	.64
Ferric oxid, Fe_2O_3	.40
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	53.00
Magnesium oxid, MgO	.64
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Potash, K_2O	.23
Soda, Na_2O	.14
Total	99.90

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	94.59
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.34

(Analysis by J. S. McHargue.)

FAYETTE COUNTY

From Kentucky Geological Survey Reports, Vol. 2, O. S., pages 165-6.

No. 508.—Limestone. Labeled "Limestone used for curbstones, etc., Van Akin's quarry, just below Lexington, on the Elkhorn Branch, Fayette County, Ky." Glimmering with calcarious spar, and containing the usual fossils of the Trenton Limestone, or blue limestone of the Lower Silurian Formation.

Specific gravity, 2.711.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	77.63*
Carbonate of magnesia	10.00
Alumina, and oxides of iron and manganese	3.23
Phosphoric acid	.70
Sulphuric acid	3.12
Chlorine, not estimated.	
Potash	.32
Soda	.15
Silica and insoluble silicates	4.98
Total	100.13

*Equivalent to 43.56% lime.

The air-dried rock lost 0.20 per cent of moisture, at 212° F.

Total calcium and magnesium carbonates, 87.63.

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 2, O. S., page 169.

No. 512.—Limestone. Labeled "Building Stone, from Grimes' Quarry, Fayette County, Ky."

A light yellowish-gray, fine granular limestone, quite homogeneous in its structure, with no appearance of fossils or pyritous matter. Under the lens appears to be made up of pure crystalline grains, aggregated together without cement; powder nearly white.

Specific gravity, 2.703.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	55.54*
Carbonate of magnesia	40.80†
Alumina, oxide of iron, etc.	.96
Sulphuric acid	.02
Potash	.36
Soda	.22
Silex and insoluble silicates	2.79
Total	100.69

The air-dried rock lost 0.30 per cent of moisture, at 212° F.

Total calcium and magnesium carbnoates, 96.34.

*Equivalent to 31.16% lime.
†Equivalent to 19.68 magnesia.

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 148.

No. 965.—Limestone. Labeled "Lowest Rock at Clay's Ferry; below the birdseye limestone, Fayette County, Ky."

A compact, light dove-gray, fossiliferous rock; fracture approaching conchoidal, containing specks of calc. spar, in some cases replacing fossil shells; representing irregular veins of dirty yellowish-gray, less compact material.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	92.640
Carbonate of magnesia	3.999
Alumina, and oxides of iron and manganese	.440
Phosphoric acid	small trace
Sulphuric acid	.441
Potash, not estimated.	
Soda, not estimated.	
Silex and insoluble silicates	2.480
Total	100.000
Total calcium and magnesium carbonates	96.639

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 149-50.

No. 967.—Limestone. Labeled "Magnesian Limestone, 190 feet above low water. Stratum 5 feet thick; layers 10 to 18 inches thick, Raven Creek, Fayette County, Ky." (Obtained by Messrs. Downie and Lesquereaux.) A dull, fine-grained, homogeneous rock of a gray reddish-buff color; contains no fossils.

This limestone is of the lower silurian formation.

Composition of this limestone, dried at 212° F.

	Per cent.
Carbonate of lime	77.460
Carbonate of magnesia	15.426
Alumina, and oxide of iron and manganese	1.280
Phosphoric acid	.246
Sulphuric acid	.166
Potash	.193
Soda	.363
Silex and insoluble silicates	2.980
Water and loss	1.886
Total	100.000
Moisture, lost at 212° F.	0.010
Total calcium and magnesium carbonates	92.886

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 149-50.

No. 968.—Limestone. Labeled "Kentucky Marble (Birdseye), from Daniel Brink's quarry, 14½ miles from Lexington, in Fayette County, Ky. Layer 5¼ feet above Philip Brink's branch." (Obtained by Messrs. Downie and Lesquereaux.) A compact warm light gray, brittle limestone, mottled with darker, and containing small veins of calc. spar.

This limestone is of the Lower Silurian formation.

Composition of this limestone, dried at 212° F.

	Per cent.
Carbonate of lime	95.680
Carbonate of magnesia	2.044
Alumina, and oxide of iron and manganese	.380
Phosphoric acid	.182
Sulphuric acid	.166
Potash	.193
Soda	.048
Silex and insoluble silicates	1.580
Water and loss	
Total	100.273
Moisture, lost at 212° F.	0.010
Total calcium and magnesium carbonates	97.724

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages, 149-50.

No. 969.—Limestone. Labeled Kentucky Marble, not so compact as the preceding. From Daniel Brink's quarry, 26 feet above Philip

Brink's branch, Fayette County, Ky." (Obtained by Messrs. Downie and Lesquereaux.) A dull, fine-grained rock, dark warm-gray, mottled with darker bluish gray. Brittle.

This limestone is of the Lower Silurian formation.

Composition of this limestone, dried at 212° F.

	Per cent.
Carbonate of lime	62.680
Carbonate of magnesia	23.079
Alumina, and oxide of iron and manganese	6.060
Phosphoric acid	.246
Sulphuric acid	.441
Potash	.162
Soda	.182
Silex and insoluble silicates	5.280
Water and loss	1.870
Total	100.000
Moisture, lost at 212° F.	0.006
Total calcium and magnesium carbonates	85.759

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 149-50.

No. 970.—Limestone. Labeled "Coarse Fossiliferous Limestone," Daniel Brink's quarry, 101 feet above Philip Brink's branch, Fayette County, Ky. (Obtained by Messrs. Downie and Lesquereaux.) A bluish-gray limestone, full of entrochites, broken bi-valve shells, coral, etc. Weathered surfaces dirty-buff.

This limestone is of the Lower Silurian formation.

Composition of this limestone, dried at 212° F.

	Per cent.
Carbonate of lime	91.480
Carbonate of magnesia	1.044
Alumina, and oxides of iron and manganese	3.980
Phosphoric acid	.848
Sulphuric acid	.317
Potash	.232
Soda	.336
Silex and insoluble silicates	2.380
Water and loss	
Total	100.617
Moisture, lost at 212° F.	0.010
Total calcium and magnesium carbonates	92.524

(Analysis by Dr. Robert Peter.)

FRANKLIN COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 155.

No. 981.—Limestone. Labeled "Building Stone; a bed in the blue limestone, in the northwest part of Franklin County, Ky. Said to be fire and frost proof."

A brownish-gray, granular limestone; with many irregular pores, and small branching cavities, which are colored dirty-gray-brown; grains crystalline.

Drier at 212° it lost 0.200 per cent of moisture.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	93.580*
Carbonate of Magnesia	3.663
Alumina, and oxides of iron and manganese	.880
Phosphoric acid	.117
Sulphuric acid	.441
Potash	.057
Soda	.165
Silex and insoluble silicates	.380
Loss	.717
Total	100.000
Total calcium and magnesium carbonates	97.243

*Equivalent to 52.511% of lime.

(Analysis by Dr. Robert Peter.)

ESTILL COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 129-30.

No. 939.—Limestone. Labeled "Sub-carboniferous Limestone, used as a flux at Cottage Furnace, Estill County, Ky."

A gray, fine-granular limestone; with some blotches of dirty-buff color; no appearance of fossils. Specific gravity, 2.6823.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	92.020*
Carbonate of magnesia	.629
Alumina, and oxides of iron and manganese	1.120
Phosphoric acid	.310
Sulphuric acid	.166
Potash	.193
Soda	.083
Silex and insoluble silicates	4.580
Water and loss	.899
Total	100.000

Dried at 212° F., it lost 0.40 per cent of moisture.

Total calcium and magnesium carbonates, 92.649.

*Equivalent to 50.515% of lime.

(Analysis by Dr. Robert Peter.)

GREENUP COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 164.

No. 1009.—Limestone. Labeled "Limestone used as a flux at Kenton Furnace, Greenup County, Ky. (Sub-carboniferous.)

A dense, very fine-grained, light-gray limestone; traversed by small veins of calc. spar. Specific gravity, 2.7065.

Composition, dried at 212° C.

	Per cent.
Carbonate of lime	94.980*
Carbonate of magnesia	1.583
Alumina, and oxides of iron and manganese	.580
Phosphoric acid	trace
Sulphuric acid	.317
Potash	.212
Soda	.140
Silex and insoluble silicates	2.080
Loss	.108
Total	100.000
Total calcium and magnesium carbonates	96.563

*Equivalent to 53.293% of lime.

(Analysis by Dr. Robert Peter.)

HARDIN COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 178-9.

No. 1037.—Limestone. Labeled "Lithographic Stone, Sinking Creek, Hardin County, Ky. Sub-carboniferous."

Of a light buff-gray color. Fine granular; pretty uniform in structure; only a few specks of oxide of iron in places; and some signs of fossils on the weathered surfaces. Fracture large-conchoidal.

Dried at 212° F., its powder lost 0.30 per cent of moisture.

	Per cent.
Carbonate of lime	79.180
Carbonate of magnesia	11.469
Alumina, and oxides of iron and manganese	.880
Phosphoric acid	.156
Sulphuric acid	.338
Potash	.173
Soda	.098
Silex and insoluble silicates	6.980
Loss	.726
Total	100.000
Total calcium and magnesium carbonates	90.649

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 178-9.

No. 1039.—Limestone. Labeled "Oolitic Limestone. Sub-carboniferous. One and a half miles south of Big Spring, Hardin County, Ky. On the farm of Mr. Mooreman, about the level of the first red soil and subsoil of the sub-carboniferous. The first bed under the millstone grit." (Sent by S. S. Lyon, Esq.)

A dull, chalky-white rock, principally made up of very small, round, oolitic grains. Reddish on the exterior surface, where it is porous from the dropping out of the round grains.

Dried at 212° F., it lost 0.30 per cent of moisture.

	Per cent.
Carbonate of lime	98.580
Carbonate of magnesia	.629
Alumina, and oxides of iron and manganese	.460
Phosphoric acid	.125
Sulphuric acid	.274
Potash	.154
Soda	.022
Silex and insoluble silicates	.380
Total	100.624
Total calcium and magnesium carbonates	99.209

(Analysis by Dr. Robert Peter.)

HENDERSON COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 182.

No. 1046.—Limestone. Labeled "Limestone, from Mount Zion, Henderson County, Ky. (Coal Measures.)"

A dull, fine-grained, fossiliferous limestone, with a few glimmering facets of calc. spar.

Dried at 212° F., it lost 0.20 per cent of moisture.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	88.380
Carbonate of magnesia	3.678
Alumina and oxides of iron and manganese	1.760
Phosphoric acid	.246
Sulphuric acid	.166
Potash	.289
Soda	.068
Silex and insoluble silicates	3.280
Water and loss	2.133
Total	100.000
Total calcium and magnesium carbonates	92.058

(Analysis by Dr. Robert Peter.)

JEFFERSON COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 189.

No. 1065.—Limestone. Labeled "Variegated Limestone; near the base of the Upper Silurian, of Jefferson County, three miles from Middletown, on the Shelbyville road."

A fine-granular limestone, of a brownish-yellow, or dirty-orange color, mottled and striped with greenish-gray. Powder light-yellowish. Dried at 212° F., it lost 0.35 per cent of moisture.

Composition, dried at 400° F.

	Per cent.
Carbonate of lime	52.080
Carbonate of magnesia	31.473
Alumina, and oxides of iron and manganese	4.473
Phosphoric acid	.208
Sulphuric acid	.303
Potash	.606
Soda	.307
Silex and insoluble silicates	10.480
Total	100.009
Total calcium and magnesium carbonates	83.553

(Analysis by Dr. Robert Peter.)

August 18, 1906.

Laboratory No. G-2715.—Limestone, labeled "Main quarry ¼ mile east of Tucker, Jefferson County, Ky. Geological position Lower Laurel. Collected by A. F. Foerste, 1906." Sample, bluish-gray, fine-grained limestone.

Analysis of the air-dried sample.

	Per cent.
Moisture	.38
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.68
Silica, SiO_2	5.64
Alumina, Al_2O_3	2.74
Ferric oxid, Fe_2O_3	1.00
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	32.52
Magnesium oxid, MgO	14.49
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	.08
Sulfur, S	.14
Phosphorus, P	trace
Total	99.67

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	58.07
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	30.43

(Analysis by O. M. Shedd.)

August 18, 1906.

Laboratory No. G-2711.—Limestone, labeled "Florida Heights quarry, Jefferson County, Ky. Geological position, Louisville limestone, 23 ft. to 60 ft. below Devonian base. Collected by A. F. Foerste, 1906."

Analysis of the air-dried sample.	Per cent.
Moisture	.24
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.48
Silica, SiO_2	3.98
Alumina, Al_2O_3	2.50
Ferric oxid, Fe_2O_3	.45
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	42.88
Magnesium oxid, MgO	7.42
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	.05
Sulfur (total), S	.17
Phosphorus, P	trace
Total	100.17
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	76.57
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	15.58

(Analysis by O. M. Shedd.)

August 18, 1906.

Laboratory No. G-2710.—Limestone, labeled "Florida Heights quarry, Jefferson County, Ky. Geological position Louisville limestone 8 to 23 ft. below Devonian base. Collected by A. F. Foerste, 1906." A hard, gray, fine-grained limestone—a few of the pieces brownish.

Analysis of the air-dried sample.	Per cent.
Moisture	.28
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.36
Silica, SiO_2	6.46
Alumina, Al_2O_3	2.94
Ferric oxid, Fe_2O_3	.52
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	39.16

Magnesium oxid, MgO	8.90
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	.08
Sulfur (total), S	.33
Total	100.03
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	69.93
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	18.69

(Analysis by O. M. Shedd.)

August 7, 1906.

Laboratory No. G-2700.—Limestone, labeled "No. 2 Cox quarry, 1⅓ miles east of Anchorage in Jefferson County. Geological position Upper Laurel, 0-17 ft. below Waldron. Collected by A. F. Foerste." Average sample of hard, brownish and bluish limestone. Fractured surfaces rough and granular and somewhat cellular.

Analysis of the air-dried sample.	Per cent.
Moisture	.17
Ignition (carbon dioxid, organic matter, combined water, etc.)	44.83
Silica, SiO_2	4.03
Alumina, Al_2O_3 / Ferric oxid, Fe_2O_3	2.22
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	30.75
Magnesium oxid, MgO	17.59
Phosphorus pentoxid, P_2O_5	.03
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Sulfur, S	trace
Total	99.62
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	54.91
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	36.94

(Analysis by O. M. Shedd.)

JESSAMINE COUNTY

November 6, 1911.

Laboratory No. G-3443.—Limestone labeled "High Bridge, Ky. Full section of that part of the Camp Nelson bed which is exposed here. This equals the upper 150 ft. of the Camp Nelson bed. Road leading west to the river level. Four pounds of limestone weathering so as to have yellowish spots. Collected by A. F. Foerste, 1911.

Analysis of the air-dried sample.	Per cent.
Moisture	.10
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.32
Silica, SiO_2	3.84
Alumina, Al_2O_3	.05
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	50.06
Magnesium oxid, MgO	2.11
Phosphorus pentoxid, P_2O_5	.25
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	99.21
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	89.40
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	4.43

(Analysis by J. S. McHargue.)

June 11, 1910.

Laboratory No. G-3224.—Limestone, taken from top layers of the American Ballast Company's quarry about ¼ mile north of High Bridge, Ky. The sample represents about 10 ft. vertical section of the rock just above the green clay, near the spring. Collected by J. S. McHargue, June 11, 1910.

Analysis of the air-dried sample.	Per cent.
Moisture	.23
Ignition (carbon dioxid, organic matter, combined water, etc.)	36.84
Silica, SiO_2	13.16
Alumina, Al_2O_3	1.98
Ferric oxid, Fe_2O_3	.80
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	45.20
Magnesium oxid, MgO	1.19
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Potash, K_2O	1.34
Sodium oxid, Na_2O	0.00
Total	100.74
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	80.71
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	2.50

(Analysis by J. S. McHargue.)

LOGAN COUNTY

September 5, 1906.

Laboratory No. G-2723.—Limestone labeled "Whittaker's farm, 3 miles south of Russellville. Geological position, above clay at intervals for 3 ft. Collected by S. A. Denny." Sample, a hard, gray limestone.

Analysis of the air-dried sample.	Per cent.
Moisture	0.44
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.36
Silica, SiO_2	3.06
Alumina, Al_2O_3	.36
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	50.70
Magnesium oxid, MgO	2.86
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Titanium and phosphorus	traces
Sulfur (total), S	.03
Total	100.29
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	90.54
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	6.05

(Analysis by O. M. Shedd.)

MADISON COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 212.

No. 1123.—Limestone. Labeled "Magnesian Limestone; a good building stone; from Mr. Covington's farm, at Elliston, Madison County, Ky. (where the red-bud soil was collected)."

A dull, dark, buff-gray, fine-granular rock. Powder light gray-buff color. Specific gravity, 2.6912.

Dried at 212° F., it lost 0.20 per cent of moisture.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	49.320
Carbonate of magnesia	30.729
Alumina, and oxides of iron and manganese	2.960
Phosphoric acid	.271
Sulphuric acid	.509

Potash	.374
Soda	.058
Silex and insoluble silicates	14.180
Loss	1.599
Total	100.000
Total calcium and magnesium carbonates	80.049

February 11, 1908.

Laboratory No. G-2844.—Garrard sandstone, labeled "½ mile east of Foster Station (Flag Station), 4 miles west of Richmond, Ky., just east of Eliza Foster. Geological position, Garrard sandstone. Massive sandstone, weathered appearance. Collected by A. F. Foerste March 22, 1907. This is the weathered form of the Garrard sandstone of which the other sample (No. G-2864) is the unweathered form."

Sample, about ½ lb. of yellowish-brown powder.

Analysis of the air-dried sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	5.77
Silica, SiO_2	73.58
Alumina, $Al_2O_3+P_2O_5+TiO_2$	12.31
Ferric oxid, Fe_2O_3	2.72
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	1.75
Magnesium oxid, MgO	.90
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Potash, K_2O	2.13
Sodium oxid, Na_2O	.24
Total	99.40
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	3.12
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.89

(Analysis by J. S. McHargue.)

May 28, 1908.

Laboratory No. G-2864.—Garrard sandstone, labeled "About ¼ mile east of Foster Flag Station, 4 miles west of Richmond, Ky. Geological position, Garrard sandstone. Massive section 0-18 ft. above railroad. Collected by A. F. Foerste, March 22, 1907."

Analysis of the air-dried sample.	Per cent.
Moisture	.05
Ignition (carbon dioxid, organic matter, combined water, etc.)	17.62
Silica, SiO_2	47.16
Alumina, Al_2O_3	7.47
Ferric oxid, Fe_2O_3 / Ferrous oxid, FeO	2.16
Calcium oxid, CaO	18.30
Magnesium oxid, MgO	3.31
Phosphorus pentoxid, P_2O_5	1.07
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Potash, K_2O	1.75
Sodium oxid, Na_2O	.66
Total	99.55
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	32.67
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	6.95

(Analysis by J. S. McHargue.)

January 4, 1911.

Laboratory No. G-3264.—Limestone labeled "St. Louis clayey limestone, basal 32 ft. above 12½ ft. of Keokuk on Big Hill, Madison County at junction with Jackson and Rockcastle counties. Collected by F. J. Fohs, August 13, 1910."

Average sample of medium sized lumps of gray crystalline limestone with a few lumps of yellowish stone which appeared to have been altered by weathering. The yellow lumps contained cavities of calcite.

Analysis of the air-dried sample.	Per cent.
Moisture	.19
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.65
Silica, SiO_2	7.70
Alumina, Al_2O_3	2.94
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	.86
Calcium oxid, CaO	39.09
Magnesium oxid, MgO	7.96
Phosphorus pentoxid, P_2O_5	.34
Sulfur trioxid, SO_3	.13
Titanium dioxid, TiO_2	trace
Total	100.18

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	69.80
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	16.71
Total calcium and magnesium carbonates	86.51

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3267.—"Oolite, thickness 8 ft., fine laminated. Just above pink flint. Conglomerate of St. Louis. On Big Hill, near junction of Madison with Rockcastle and Jackson counties, Madison County, Ky. Collected by F. J. Fohs, August 13, 1910."

Average sample of medium sized lumps of light-gray oolitic limestone. Irregular fracture. Pure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.11
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.89
Silica, SiO_2	3.80
Alumina, Al_2O_3	.48
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	.14
Calcium oxid, CaO	52.86
Magnesium oxid, MgO	.73
Phosphorus pentoxid, P_2O_5	.12
Sulfur trioxid, SO_3	.03
Titanium dioxid, TiO_2	trace
Total	100.48
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	94.40
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.53
Total calcium and magnesium carbonates	95.93

(Analysis by J. S. McHargue.)

MEADE COUNTY

September 11, 1908.

Laboratory No. G-2872.—"Supposed lithographic stone. South outcrop, Mooreman land, Meade County. Fine grained, gray stone with broad conchoidal fracture. Does not adhere to tongue." Received from F. J. Fohs, July 22, 1908.

Specific gravity, 2.70.

Analysis of the air-dry sample.	Per cent.
Moisture	0.02
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.66
Silica, SiO_2	2.76
Alumina, Al_2O_3	.40
Ferric oxid, Fe_2O_3	.80
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	46.00
Magnesium oxid, MgO	6.53
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Alkalies	trace
Sand	trace
Total	100.17
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	82.14
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	13.71
Total calcium and magnesium carbonates	95.85

(Analysis by J. S. McHargue.)

September 11, 1908.

Laboratory No. 7-2873.—"Supposed lithographic stone. Topmost layer of lower ledge No. 1 quarry, Mooreman land, Meade County, Ky. Gray stone about ¼ lb. fragments broken from cabinet specimen. Does not adhere to tongue. Received from F. J. Fohs, July 22, 1908."

Specific gravity, 2.648.

Analysis of the air-dry sample.	Per cent.
Moisture	0.05
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.32
Silica, SiO_2	1.78
Alumina, Al_2O_3	.14
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	52.40
Magnesium oxid, MgO	1.04
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.21

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	93.57
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	2.18
Total calcium and magnesium carbonates	95.75

(Analysis by J. S. McHargue.)

September 11, 1908.

Laboratory No. G-2874.—"Supposed lithographic stone, second layer of lowest ledge No. 2 quarry, Mooreman land, Meade County. Light buff colored stone, parts showing a peculiar 'worm-eaten' appearance. Considerably weathered. Adheres slightly to tongue. Received from F. J. Fohs, July 22, 1908."

Specific gravity, 2.52.

Analysis of the air-dry sample.	Per cent.
Moisture	0.03
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.90
Silica, SiO_2	1.96
Alumina, Al_2O_3	.14
Ferric oxid, Fe_2O_3	.56
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	53.90
Magnesium oxid, MgO	.57
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	100.06
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	96.25
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.20
Total calcium and magnesium carbonates	97.45

(Analysis by J. S. McHargue.)

December 11, 1908.

Laboratory No. G-2918.—"Lithographic stone sent by J. Stoddard Johnston of Louisville, Ky. The sample consisted of a small hand specimen of brownish looking stone having a conchoidal fracture."

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.10
Silica, SiO_2	4.20
Alumina, Al_2O_3	0.30
Ferric oxid, Fe_2O_3	.40

Ferrous oxid, FeO	0.00
Calcium oxid, CaO	48.30
Magnesium oxid, MgO	3.70
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.00
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	86.25
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	7.77
Total calcium and magnesium carbonates	94.02

(Analysis by J. S. McHargue.)

December 11, 1908.

Laboratory No. G-2920.—"Lithographic stone sent by J. Stoddard Johnston of Louisville, Ky. The sample consisted of a fair-sized hand specimen of brown and gray bands and having a slight conchoidal fracture.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.64
Silica, SiO_2	3.60
Alumina, Al_2O_3	.12
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	50.20
Magnesium oxid, MgO	2.67
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	99.71
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	89.11
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	5.61
Total calcium and magnesium carbonates	94.72

(Analysis by J. S. McHargue.)

June 10, 1909.

Laboratory No. G-3076.—Limestone sent by J. S. Johnston, of Louisville, Ky. Sample consisted of a very small chip of grayish looking limestone. "No. 1 from Meade County, higher up the river above Doe Run, where the railroad southward diverges from the river.

Thickness 15 or 20 ft. Seems more of a cement rock than lithographic."

Analysis of the air-dry sample.

	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.00
Silica, SiO_2	6.60
Alumina, Al_2O_3	1.00
Ferric oxid, Fe_2O_3	.64
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	49.20
Magnesium oxide, MgO	2.17
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.61
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	87.85
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	4.56
Total calcium and magnesium carbonates	92.41

(Analysis by J. S. McHargue.)

MORGAN COUNTY

May 26, 1911.

Laboratory No. G-3363.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky., 8″ 20′."

The sample consisted of a hand specimen weighing about 1¾ lbs. of dark gray oolitic limestone having an irregular fracture. The stone was composed of a mass of dark and light gray oolites.

Analysis of the air-dry sample.

	Per cent.
Moisture	.14
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.28
Silica, SiO_2	5.90
Alumina, Al_2O_3	.38
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	trace
Calcium oxid, CaO	51.30
Magnesium oxid, MgO	.48
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.80

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	91.60
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.00
Total calcium and magnesium carbonates	92.60

(Analysis by J. S. McHargue.)

May 26, 1911.

Laboratory No. G-3362.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "No. 6, 19½ ft. from bottom, 20 ft. thick."

The sample consisted of a hand specimen weighing about 1 lb. of light gray colored, crystalline limestone having an irregular fracture. One surface was honey-combed by weathering. A pure looking stone.

Analysis of air-dried sample.	Per cent.
Moisture	.12
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.74
Silica, SiO_2	.50
Alumina, Al_2O_3	.26
Ferric oxid, Fe_2O_3	.16
Ferrous oxid, FeO	trace
Calcium oxid, CaO	54.55
Magnesium oxid, MgO	.51
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.84
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	97.40
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.07
Total calcium and magnesium carbonates	98.47

(Analysis by J. S. McHargue.)

May 26, 1911.

Labroatory No. G-3361.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "No. 5, 15½ ft. from bottom, 3½ ft. thick."

The sample consisted of a hand specimen weighing about 1 lb. of brown, fine grained, slightly crystalline limestone having a conchoidal and flinty fracture. One surface was weathered.

Analysis of the air-dry sample.	Per cent.
Moisture	.22
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.62
Silica, SiO_2	5.02
Alumina, Al_2O_3	.80
Ferric oxid, Fe_2O_3	.64
Ferrous oxid, FeO	trace
Calcium oxid, CaO	47.94
Magnesium oxid, MgO	2.91
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.15
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	85.60
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	6.11
Total calcium and magnesium carbonates	91.71

(Analysis by J. S. McHargue.)

May 26, 1911.

Laboratory No. G-3360.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "No. 4, 14 ft. from bottom, 1½ ft. thick. Brown marble."

The sample consisted of a hand specimen weighing about 2 lbs. of brown, fine grained, slightly crystalline limestone having a marked conchoidal fracture.

Analysis of the air-dry sample.	Per cent.
Moisture	.20
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.66
Silica, SiO_2	5.96
Alumina, Al_2O_3	.30
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	trace
Calcium oxid, CaO	48.55
Magnesium oxid, MgO	2.57
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.72

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	86.70
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	5.40
Total calcium and magnesium carbonates	92.10

(Analysis by J. S. McHargue.)

May 26, 1911

Laboratory No. G-3359.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "No. 3, 14 ft. from bottom."

The sample consisted of a hand specimen weighing about ½ lb. of light gray, slightly crystalline limestone having an irregular fracture. A rather hard stone. One surface was somewhat honeycombed by weathering.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.20
Silica, SiO_2	1.80
Alumina, Al_2O_3	.48
Ferric oxid, Fe_2O_3	.16
Ferrous oxid, FeO	trace
Calcium oxid, CaO	53.20
Magnesium oxid, MgO	.57
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.41
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	95.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.20
Total calcium and magnesium carbonates	96.20

(Analysis by J. S. McHargue.)

May 26, 1911.

Laboratory No. G-3358.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "No. 2, 6 ft. from bottom."

The sample consisted of a hand specimen weighing about ½ lb. of olive-gray, non-crystalline limestone having an irregular flinty fracture. Contained fissure veins containing crystals of calcite and some more or less greenish coloration. One surface had weathered to a gray color.

Analysis of the air-dry sample.	Per cent.
Moisture	.06
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.14
Silica, SiO_2	7.62
Alumina, Al_2O_3	1.18
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	trace
Calcium oxid, CaO	49.28
Magnesium oxid, MgO	.76
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.52
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	88.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.60
Total calcium and magnesium carbonates	89.60

(Analysis by J. S. McHargue.)

May 26, 1911.

Laboratory No. G-3357.—Limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "No. 1, bottom line."

The sample consisted of a ½ lb. hand specimen of dark gray with slightly greenish laminations of non-crystalline limestone having a rather flinty and irregular fracture. One surface was weathered.

Analysis of the air-dry sample.	Per cent.
Moisture	.18
Ignition (carbon dioxid, organic matter, combined water, etc.)	39.36
Silica, SiO_2	8.46
Alumina, Al_2O_3	1.64
Ferric oxid, Fe_2O_3	.80
Ferrous oxid, FeO	trace
Calcium oxid, CaO	48.50
Magnesium oxid, MgO	.78
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.72

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	86.60
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.64
Total calcium and magnesium carbonates	88.24

(Analysis by J. S. McHargue.)

May 26, 1911.

Laboratory No. G-3356.—Sample of limestone sent by Dr. S. R. Collier of West Liberty, Morgan County, Ky. "8-12 ft. Yale Section."

The sample consisted of a small handful of fresh chips of olive-gray, non-crystalline limestone having a marked conchoidal and flinty fracture. The sample weighed about ⅛ lb.

Analysis of the air-dry sample.	Per cent.
Moisture	.24
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.36
Silica, SiO_2	3.74
Alumina, Al_2O_3	1.42
Ferric oxid, Fe_2O_3	.80
Ferrous oxid, FeO	trace
Calcium oxid, CaO	51.18
Magnesium oxid, MgO	.87
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	99.61
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	91.40
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.83
Total calcium and magnesium carbonates	93.23

(Analysis by J. S. McHargue.)

NELSON COUNTY

From Kentucky Geological Survey Reports, Vol. 3, O. S., pages 341-2.

No. 709.—Limestone (magnesian). Labeled "Magnesian building stone. Bardstown, Nelson County, Kentucky. Upper Silurian formation."

A gray-buff, fine-granular rock; not adhering to the tongue. Under the lens appearing to be made up of pretty pure crystalline grains. Powder of a light gray color.

The air-dried powdered stone lost only 0.10 per cent of moisture at 212° F.

Specific gravity, 2.758.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	62.19*
Carbonate of magnesia	33.90
Alumina, and oxides of iron and manganese and trace of phosphates	.68
Potash	.46
Soda	.35
Silex and insoluble silicates	3.18
Total	100.76
Total calcium and magnesium carbonates	96.09

*Equivalent to 34.90% of lime.

This magnesian limestone was found to contain only a very small trace of sulfur. It does not differ greatly in composition from the limestone rocks of the lower strata of the Lower Silurian formation, and will doubtless be found a very durable building material. (Analysis by Dr. Robert Peter.)

NICHOLAS COUNTY

February 11, 1908.

Labratory No. G-2840.—Limestone, labeled "Upper 20 ft. of Cynthiana formation, Pleasant Valley, Ky. Collected by A. F. Foerste, May 18, 1907. This is the Point Pleasant bed." Coarse powdered sample of about ½ lb. of gray limestone.

Analysis dried at 100° C.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.80
Silica, SiO_2	1.38
Alumina, Al_2O_3 / Ferric oxid, Fe_2O_3	.90
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	53.48
Magnesium oxid, MgO	.86
Phosphorus pentoxid, P_2O_5	.30
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	99.72
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	95.50
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.81
Total calcium and magnesium carbonates	97.31

(Analysis by J. S. McHargue.)

OHIO COUNTY

November 22, 1909.

Laboratory No. G-3180.—"Gray limestone from Powers place on I. C. R. R, branch between Owensboro and Horse Branch, Ohio County, Ky. Sent by L. Rosenfield, Henderson, Ky."

Sample consisted of a rather large sized hand specimen of limestone having an irregular fracture and a grayish-brown color.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.88
Silica, SiO_2	1.14
Alumina, Al_2O_3	1.08
Ferric oxid, Fe_2O_3	1.76
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	52.28
Magnesium oxid, MgO	.83
Phosphorus pentoxid, P_2O_5	.22
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.19
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	93.35
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.74
Total calcium and magnesium carbonates	95.09

(Analysis by J. S. McHargue.)

November 22, 1909.

Laboratory No. G-3179.—"Blue limestone from Powers place on I. C. R. R., branch between Owensboro and Horse Branch in Ohio County, Ky. Sent by L. Rosenfield, Henderson, Ky."

Sample consisted of a rather large hand specimen of dark-gray limestone containing fossils.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.36
Silica, SiO_2	6.36
Alumina, Al_2O_3	3.57
Ferric oxid, Fe_2O_3	.96
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	46.30
Magnesium oxid, MgO	2.52
Phosphorus pentoxid, P_2O_5	.09
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.16

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	82.68
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	5.29
Total calcium and magnesium carbonates	87.97

(Analysis by J. S. McHargue.)

OLDHAM COUNTY

August 18, 1906.

Laboratory No. G-2717.—Limestone labeled "Cut at overhead bridge 2 miles east of La Grange, Oldham County, Ky. Geological position, Osgood limestone. Collected by A. F. Foerste, 1906. Complete section sampled. Stone can be secured in large quantity immediately along the L. & N. Railroad." Reddish-brown or pinkish limestone of rough texture and somewhat cellular.

Analysis of the air-dry sample.	Per cent.
Moisture	0.38
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.98
Silica, SiO_2	5.72
Alumina, Al_2O_3	2.28
Ferric oxid, Fe_2O_3	1.04
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	28.92
Magnesium oxid, MgO	18.84
Phosphorus pentoxid, P_2O_5	trace
Sulfur, S	.03
Titanium dioxid, TiO_2	.08
Total	100.27
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	51.61
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	39.56
Total calcium and magnesium carbonates	91.17

(Analysis by J. S. McHargue.)

August 7, 1906.

Laboratory No. G-2701.—Limestone labeled "No. 3, locality No. 67, 1½ miles northwest of Beards in Oldham County. Geological position, Clinton. Collected by A. F. Foerste." Average sample of brownish, hard, rough and cellular limestone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.04
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.27
Silica, SiO_2	1.00
Alumina, Al_2O_3 / Ferric oxid, Fe_2O_3	.71
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	54.44
Magnesium oxid, MgO	.87
Phosphorus pentoxid, P_2O_5	.12
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Total	100.45
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	97.21
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.93
Total calcium and magnesium carbonates	99.14

(Analysis by Averitt, McClelland and Edgar.)

PIKE COUNTY

September 6, 1921.

Laboratory No. G-4065.—Labeled "Fine grained micaceous sandstone, Pikeville, Pike County, Ky. July 15, 1921. By. Prof. C. H. Richardson." The sample was a half pound lump of pale, neutral-gray, fine-grained stone containing brown particles and small scales of mica.

Analysis of the air-dry sample.	Per cent.
Moisture	0.20
Ignition	2.49
Silica, SiO_2	75.92
Ferric oxid, Fe_2O_3	2.89
Alumina, Al_2O_3	13.47
Titanium dioxid, TiO_2	0.40
Calcium oxid, CaO	1.10
Magnesium oxid, MgO	0.72
Potassium oxid, K_2O	2.28
Soda and loss	0.53
Total	100.00

ALFRED M. PETER, Chief Chemist.

(Analysis by W. D. Iler.)

POWELL COUNTY

November 18, 1908.

Laboratory No. G-2914.—"Limestone for Portland cement, Patrick Cement Company. Oolitic and crystalline limestone, over 50 ft. thick, Ste. Genevieve limestone. Collected by F. Julius Fohs."

Fragments of a rather grayish-white, weathered limestone. The sample consisted of about ½ lb. of small, irregular fragments, which seemed to have been chipped from weathered portions of parent stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.06
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.10
Silica, SiO_2	1.52
Alumina, Al_2O_3	.18
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	53.20
Magnesium oxid, MgO	.50
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	99.04
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	95.07
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.05
Total calcium and magnesium carbonates	96.12

(Analysis by J. S. McHargue.)

ROCKCASTLE COUNTY

Laboratory No. G-2606.—Limestone, labeled "Near Gum Sulphur, Rockcastle County, Ky. Geological position Devonian (?). Brought by Dr. W. W. Burgin, Richmond, Ky."

Sample, a 16 oz. piece of gray, very crystalline limestone containing pink crinoid stems and pink calcite crystals and occasional spots of soft, greenish, clay-like material among the crystals. Fragments of brachiopod shells were noted occasionally.

Analysis of the air-dry sample.	Per cent.
Moisture	0.11
Ignition	43.78
Silica	.27
Ferric oxid, alumina, etc.	.41
Lime	54.82*

Magnesia*	.55
Sulphur trioxid	.02
Phosphorus pentoxid	trace
Total	99.96

*Equivalent to 97.89% calcium carbonate.

(Analysis by S. D. Averitt.)

July 14, 1911.

Laboratory No. G-3291.—"First limestone above base of Birdsville formation. Thickness 20 ft. 6 ins. On hill directly south of depot at Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 10, 1910."

Average sample of gray, crystalline limestone having a conchoidal fracture. Some coating of iron oxid on weathered surface.

Moisture	0.12
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.86
Silica, SiO_2	3.44
Alumina, Al_2O_3	.21
Ferric oxid, Fe_2O_3	0.00
Ferrous oxid, FeO	.43
Calcium oxid, CaO	51.44
Magnesium oxid, MgO	1.76
Phosphorus pentoxid, P_2O_5	.05
Sulfur trioxid, SO_3	.07
Titanium dioxid, TiO_2	0.00
Total	99.38
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	91.70
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	3.70
Total calcium and magnesium carbonates	95.40

(Analysis by J. S. McHargue.)

July 14, 1911.

Laboratory No. G-3290.—"Third limestone from base of Birdsville, thickness 23 ft. 11 ins., on hill directly south of depot at Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 10, 1910.

Average sample of dark-gray, rather impure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.11
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.80
Silica, SiO_2	4.58
Alumina, Al_2O_3	.84

Ferric oxid, Fe_2O_3	0.00
Ferrous oxid, FeO	.79
Calcium oxid, CaO	48.32
Magnesium oxid, MgO	2.28
Phosphorus pentoxid, P_2O_5	.03
Sulfur trioxid, SO_3	.57
Titanium dioxid, TiO_2	0.00
Total	99.32
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	86.28
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	4.79
Total calcium and magnesium carbonates	91.07

(Analysis by J. S. McHargue.)

November 7, 1910.

Laboratory No. G-3289.—"Crystalline, oolitic limestone with large crinoid stems, zaphrenti and agassizocrins conicus. Thickness, 24 ft. 10 ins. Top beds of Tribune limestone. Sparks Quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of crystalline, oolitic limestone containing cavities of iron oxid.

Analysis of the air-dry sample.	Per cent.
Moisture at 100° C.	0.07
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.00
Silica, SiO_2	1.66
Alumina, Al_2O_3	.52
Ferric oxid, Fe_2O_3	.16
Ferrous oxid, FeO	.22
Calcium oxid, CaO	53.76
Magnesium oxid, MgO	.67
Phosphorus pentoxid, P_2O_5	.02
Sulfur trioxid, SO_3	.01
Titanium dioxid, TiO_2	0.00
Strontium, Sr.	trace
Total	100.09
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	96.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.41
Total calcium and magnesium carbonates	97.41

(Analysis by J. S. McHargue.)

November 7, 1910.

Laboratory No. G-3288.—"White oolite. Thickness 17 ft. 10 ins. Krugers lime quarry, directly south of depot at Mt. Vernon. Mt. Vernon bed, Ste. Genevieve limestone, Rockcastle County, Ky. Collected by F. J. Pohs, August 10, 1910."

Average sample of white oolitic limestone. Looks like a finer grained stone than the Bedford and a fewer number of oolites.

Analysis of the air-dry sample.	Per cent.
Moisture	0.02
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.50
Silica, SiO_2	.52
Alumina, Al_2O_3	.16
Ferric oxid, Fe_2O_3	.08
Ferrous oxid, FeO	.07
Calcium oxid, CaO	55.19
Magnesium oxid, MgO	.38
Phosphorus pentoxid, P_2O_5	.05
Sulfur trioxid, SO_3	.01
Titanium dioxid, TiO_2	0.00
Strontium, Sr	traces
Total	99.98
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	99.55
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	.79
Total calcium and magnesium carbonates	99.34

(Analysis by J. S. McHargue.)

July 14, 1911.

Laboratory No. G-3287.—"Dark oolite cross bedded No. 5 of Mt. Vernon, Ste. Genevieve Section. Spark's quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of gray, oolitic limestone. A rather firm stone, some of the chips being slightly weathered.

Analysis of the air-dry sample.	Per cent.
Moisture	0.13
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.84
Silica, SiO_2	5.72
Alumina, Al_2O_3	.74
Ferric oxid, Fe_2O_3	.68
Ferrous oxid, FeO	.18
Calcium oxid, CaO	51.20
Magnesium oxid, MgO	.85

Phosphorus pentoxid, P_2O_5	.08
Sulfur trioxid, SO_3	.07
Titanium dioxid, TiO_2	0.00
Total	100.49
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	91.28
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.78
Total calcium and magnesium carbonates	93.06

(Analysis by J. S. McHargue.)

July 14, 1911.

Laboratory No. G-3284.—"Dark, compact, somewhat brecciated limestone, No. 8 of section of Ste. Genevieve. Thickness 3½ ft. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark limestone. A rather hard, flint-like stone.

Analysis of the air-dry sample.	Per cent.
Moisture..	0.08
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.70
Silica, SiO_2	1.24
Alumina, Al_2O_3	.26
Ferric oxid, Fe_2O_3	0.00
Ferrous oxid, FeO	.22
Calcium oxid, CaO	53.40
Magnesium oxid, MgO	.70
Phosphorus pentoxid, P_2O_5	.04
Sulfur trioxid, SO_3	.10
Titanium dioxid, TiO_2	0.00
Total	99.74
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	95.20
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.47
Total calcium and magnesium carbonates	96.67

(Analysis by J. S. McHargue.)

July 14, 1911.

Laboratory No. G-3281.—"7½ ft. of Lithostrotion beds, St. Louis limestone on Big Hill in road near junction of Madison, Jackson and Rockcastle counties, Ky. Collected by F. J. Fohs, August 13, 1910."

Average sample of dark gray limestone containing fossils which are replaced by silica. The fossils were of a beautiful pink color, probably due to iron.

Analysis of the air-dry sample.	Per cent.
Moisture	0.16
Ignition (carbon dioxid, organic matter, combined water, etc.)	38.16
Silica, SiO_2	12.16
Alumina, Al_2O_3	.34
Ferric oxid, Fe_2O_3	.56
Ferrous oxid, FeO	.22
Calcium oxid, CaO	47.98
Magnesium oxid, MgO	.38
Phosphorus pentoxid, P_2O_5	.04
Sulfur trioxid, SO_3	.01
Titanium dioxid, TiO_2	0.00
Total	100.01
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	85.56
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	.80
Total calcium and magnesium carbonates	86.36

(Analysis by J. S. McHargue.)

November 7, 1910.

Laboratory No. G-3283.—"Light pink oolite, lower 4 ft. of Mt. Vernon bed. Ste. Genevieve limestone, No. 10 of section. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August, 1910."

Average sample of yellow, oolitic limestone having a rather sandy feel. A rather friable, impure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.04
Ignition (carbon dioxid, organic matter, combined water, etc.)	44.08
Silica, SiO_2	1.60
Alumina, Al_2O_3	.31
Ferric oxid, Fe_2O_3	.24
Ferrous oxid, FeO	.36
Calcium oxid, CaO	45.36
Magnesium oxid, MgO	7.75
Phosphorus pentoxid, P_2O_5	.05
Sulfur trioxid, SO_3	.02
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.81

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	81.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	16.25
Total calcium and magnesium carbonates	97.25

(Analysis by J. S. McHargue.)

November 7, 1910.

Laboratory No. G-3282.—"White oolitic limestone from lower 2½ ft. of upper half, 4 ft. of Mt. Vernon bed. Ste. Genevieve limestone. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

White oolitic limestone, very much like the Bedford stone in appearance. A few crystals of calcite observed. A pure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.03
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.38
Silica, SiO_2	.74
Alumina, Al_2O_3	.21
Ferric oxid, Fe_2O_3	.04
Ferrous oxid, FeO	.11
Calcium oxid, CaO	54.96
Magnesium oxid, MgO	.54
Phosphorus pentoxid, P_2O_5	.03
Sulfur trioxid, SO_3	.02
Titanium dioxid, TiO_2	0.00
Strontium, Sr	traces
Total	100.06
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	98.15
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.13
Total calcium and magnesium carbonates	99.28

(Analysis by J. S. McHargue.)

November 7, 1910.

Laboratory No. G-3280.—"White oolitic limestone. Sparks' bed. No. 18 of Mt. Vernon section of Ste. Genevieve. Thickness, 9 ft. 5 ins. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium sized lumps of light-gray limestone. A rather pure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.03
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.36
Silica, SiO_2	1.20
Alumina, Al_2O_3	.31
Ferric oxid, Fe_2O_3	.12
Ferrous oxid, FeO	.18
Calcium oxid, CaO	52.86
Magnesium oxid, MgO	1.99
Phosphorus pentoxid, P_2O_5	.03
Sulfur trioxid, SO_3	.01
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	100.09
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	94.40
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	4.18
Total calcium and magnesium carbonates	98.58

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3279.—"Semi-lithographic limestone, upper layers brecciated. Flint bands in upper part. Thickness 5 ft. 6 ins. No. 15 of Mt. Vernon, Ste. Genevieve limestone section. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium sized lumps of yellowish-gray, flinty limestone having a conchoidal fracture.

Analysis of the air-dry sample.	Per cent.
Moisture	0.15
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.99
Silica, SiO_2	6.28
Alumina, Al_2O_3	.05
Ferric oxid, Fe_2O_3	0.00
Ferrous oxid, FeO	.14
Calcium oxid, CaO	51.13
Magnesium oxid, MgO	.62
Phosphorus pentoxid, P_2O_5	.09
Sulfur trioxid, SO_3	.04
Titanium dioxid, TiO_2	0.00
Total	99.49

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	91.31
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.30
Total calcium and magnesium carbonates	92.61

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3275.—"Gray oolite, thickness 8 ins. No. 9 of Mt. Vernon section of Ste. Genevieve limestone. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark oolitic limestone. A very impure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.12
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.24
Silica, SiO_2	3.48
Alumina, Al_2O_3	1.05
Ferric oxid, Fe_2O_3	.04
Ferrous oxid, FeO	.18
Calcium oxid, CaO	52.43
Magnesium oxid, MgO	.69
Phosphorus pentoxid, P_2O_5	.09
Sulfur trioxid, SO_3	.07
Titanium dioxid, TiO_2	trace
Total	100.39
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	93.63
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.45
Total calcium and magnesium carbonates	95.08

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3272.—"Laminated compact granular limestone. Thickness 2 ft. 6 ins. No. 27 of Mt. Vernon, Ste. Genevieve section. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium and small sized lumps of dark-gray limestone having streaks of green in places. A rather fine-grained stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.16
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.36
Silica, SiO_2	4.42
Alumina, Al_2O_3	1.58
Ferric oxid, Fe_2O_3	.20
Ferrous oxid, FeO	.18
Calcium oxid, CaO	50.82
Magnesium oxid, MgO	.91
Phosphorus pentoxid, P_2O_5	.06
Sulfur trioxid, SO_3	.04
Titanium dioxid, TiO_2	trace
Total	99.73
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	90.75
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.91
Total calcium and magnesium carbonates	92.66

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3270.—"Gray, coarsely crystalline limestone, somewhat compact at the base, with pentremites phriformis. Thickness 4 ft. Basal bed of Tribune limestone. Sparks' quarry, 2 miles northeast of Mt. Vernon, Rockcastle County, Ky. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark gray, medium sized lumps of hard, flinty limestone having a conchoidal fracture.

Analysis of the air-dry sample.	Per cent.
Moisture	0.09
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.83
Silica, SiO_2	1.70
Alumina, Al_2O_3	.13
Ferric oxid, Fe_2O_3	.72
Calcium oxid, CaO	52.86
Magnesium oxid, MgO	.71
Phosphorus pentoxid, P_2O_5	.09
Sulfur trioxid, SO_3	.04
Titanium dioxid, TiO_2	trace
Total	99.39

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	94.40
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.49
Total calcium and magnesium carbonates	95.89

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3256.—"Compact, crystalline limestone. Thickness 5 ft. 8 ins., from above main Lithostrotian beds of St. Louis limestone, Rockcastle County, Ky., one mile south of Wildie, on road east of L. & N. Railroad. Collected by F. J. Fohs, August 4, 1910."

Average sample of medium sized lumps of dark gray limestone having a slight conchoidal fracture, some pieces being lighter colored than others.

Analysis of the air-dry sample.	Per cent.
Moisture	0.08
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.65
Silica, SiO_2	2.82
Alumina, Al_2O_3	1.14
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	.29
Calcium oxid, CaO	49.00
Magnesium oxid, MgO	3.28
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	traces
Total	99.58
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	87.50
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	7.09
Total calcium and magnesium carbonates	94.59

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3257.—"Dark oolite samples from outcropping beds of 62 ft. and 1 ft. compact limestone. Basal beds of Ste. Genevieve Limestone, Rockcastle County, Ky., 1¼ miles south of Wildie, on Mt. Vernon road, east of railroad, on hill. Collected by F. J. Fohs."

Average sample of medium sized lumps of light gray and somewhat oolitic limestone containing some crystals of calcite and some brown particles which had the appearance of iron oxid. A very pure looking specimen.

Analysis of the air-dry sample.	Per cent.
Moisture	0.13
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.90
Silica, SiO_2	2.26
Alumina, Al_2O_3	.62
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	.14
Calcium oxid, CaO	53.00
Magnesium oxid, MgO	.56
Phosphorus pentoxid, P_2O_5	.04
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.97
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	94.64
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.18
Total calcium and magnesium carbonates	95.82

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3258.—"Compact, and compact-crystalline limestone with lithographic bed at base. Upper part of the St. Louis limestone. Thickness sampled 8 ft. 6 ins. Rockcastle County, Ky., ¼ mile south of Mullins Station, in railroad cut. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium sized lumps of dark gray limestone, having an irregular fracture. A rather hard stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.10
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.06
Silica, SiO_2	3.02
Alumina, Al_2O_3	1.08
Ferric oxid, Fe_2O_3	.16
Ferrous oxid, FeO	.14
Calcium oxid, CaO	52.40
Magnesium oxid, MgO	.67
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.63

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	93.57
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.41
Total calcium and magnesium carbonates	94.98

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3259.—"Crystallized semi-oolitic limestone, fossiliferous. Lower bed of Upper St. Louis, 4 ft. 5 ins. thick—4 ft. where sample was taken. Rockcastle County, Ky. From railroad cut 150 yards south of Mullins depot. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium sized lumps of light gray, crystalline limestone having a slight vitreous appearance. Some crystals of calcite observed and some pieces exhibit weathering.

Analysis of the air-dry sample.	Per cent.
Moisture	0.09
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.50
Silica, SiO_2	4.88
Alumina, Al_2O_3	1.14
Ferric oxid, Fe_2O_3	.24
Ferrous oxid, FeO	.14
Calcium oxid, CaO	51.20
Magnesium oxid, MgO	.50
Phosphorus pentoxid, P_2O_5	.06
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.75
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	91.43
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.05
Total calcium and magnesium carbonates	92.48

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3260.—"Dark gray oolite, 20 ft. of, above the basal 50 ft. of the Ste. Genevieve limestone, Rockcastle County, Ky., in railroad cut just north of road crossing at Sinks. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium sized lumps of dark gray oolitic limestone. Some pieces show more oolites than others.

Analysis of the air-dry sample.	Per cent.
Moisture	0.13
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.04
Silica, SiO_2	5.60
Alumina, Al_2O_3	1.44
Ferric oxid, Fe_2O_3	.24
Ferrous oxid, FeO	.14
Calcium oxid, CaO	49.80
Magnesium oxid, MgO	.87
Phosphorus pentoxid, P_2O_5	.16
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.42
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	88.93
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.83
Total calcium and magnesium carbonates	90.76

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3261.—"Dark oolite from basal 49 ft. 2 ins. of Ste. Genevieve limestone, Rockcastle County, Ky., 2 miles south of Mullins Station, in railroad cut and north of road crossing at Sinks. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium sized lumps of dark gray oolitic limestone, some of the lumps being lighter in color than others.

Analysis of the air-dry sample.	Per cent.
Moisture	0.08
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.40
Silica, SiO_2	3.00
Alumina, Al_2O_3	.43
Ferric oxid, Fe_2O_3	.08
Ferrous oxid, FeO	.22
Calcium oxid, CaO	52.40
Magnesium oxid, MgO	.54
Phosphorus pentoxid, P_2O_5	.07
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.20

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	93.57
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.13
Total calcium and magnesium carbonates	94.70

(Analysis by J. S. McHargue.)

September 16, 1910.

Laboratory No. G-3263.—"White oolite, Sparks' bed, Rockcastle County, Ky. Thickness 10 ft. In cut just south of road crossing at Sinks. Ste. Genevieve Limestone. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium sized lumps of light gray limestone somewhat vitreous in appearance. A pure looking stone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.03
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.28
Silica, SiO_2	.94
Alumina, Al_2O_3	.06
Ferric oxid, Fe_2O_3	.16
Ferrous oxid, FeO	.14
Calcium oxid, CaO	53.80
Magnesium oxid, MgO	1.04
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	trace
Titanium dioxid, TiO_2	0.00
Strontium, Sr	trace
Total	99.45
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	96.07
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	2.18
Total calcium and magnesium carbonates	98.25

(Analysis by J. S. McHargue.)

January 4, 1911.

Laboratory No. G-3265.—"Pentremites bed, gray crystalline limestone, base of Tribune limestone, ¼ mile south of road crossing at Sinks, Rockcastle County, Ky. Collected by F. J. Fohs, August 5, 1910."

Average sample of dark gray, crystalline limestone. Medium sized lumps.

Analysis of the air-dry sample.	Per cent.
Moisture	0.15
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.02
Silica, SiO_2	1.34
Alumina, Al_2O_3	.24
Ferric oxid, Fe_2O_3	.08
Ferrous oxid, FeO	.22
Calcium oxid, CaO	54.88
Magnesium oxid, MgO	.70
Phosphorus pentoxid, P_2O_5	.30
Sulfur trioxid, SO_3	.04
Titanium dioxid, TiO_2	0.00
Total	100.97
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	98.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.48
Total calcium and magnesium carbonates	99.48

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3266.—"Crystalline, oolitic limestone with large crinoid stems which silicify on weathering. Upper 20 ft. 6 ins. of Tribune Limestone. ¼ mile south of Sinks. Collected by F. J. Fohs, August 5, 1910."

Average sample of dark-gray limestone having a slight conchoidal fracture. Decidedly crystalline in character. Crinoid stems containing calcite. No oolites observed.

Analysis of the air-dry sample.	Per cent.
Moisture	0.09
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.15
Silica, SiO_2	1.44
Alumina, Al_2O_3	.60
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	.29
Calcium oxid, CaO	52.53
Magnesium oxid, MgO	.97
Phosphorus pentoxid, P_2O_5	.08
Sulfur trioxid, SO_3	.03
Titanium dioxid, TiO_2	0.00
Total	99.50

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	93.80
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	2.03
Total calcium and magnesium carbonates	95.83

(Analysis by J. S. McHargue.)

January 5, 1911.

Laboratory No. G-3268.—"Dark oolite. Cross bedded. Thickness 20 ft. Quarried for lime at Dudley Station, Rockcastle County, Ky. Ste. Genevieve limestone. Bottom of quarry, 2 ft. above base. Collected by F. J. Fohs, August 6, 1910."

Average sample of medium sized lumps of dark oolitic limestone somewhat vitreous in appearance.

Analysis of the air-dry sample.	Per cent.
Moisture	0.14
Ignition (carbon dioxid, organic matter, combined water, etc.)	41.48
Silica, SiO_2	4.42
Alumina, Al_2O_3	1.12
Ferric oxid, Fe_2O_3	.28
Ferrous oxid, FeO	.18
Calcium oxid, CaO	51.80
Magnesium oxid, MgO	.70
Phosphorus pentoxid, P_2O_5	.12
Sulfur trioxid, SO_3	.07
Titanium dioxid, TiO_2	trace
Total	100.37
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	92.50
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.47
Total calcium and magnesium carbonates	93.97

(Analysis by J. S. McHargue.)

ROWAN COUNTY

Kentucky Geological Survey Reports, Vol. A, Part 2, page 238.

No. 2429.—Sandstone: "From the base of the Waverly formation. Sample supplied by the Freestone Company: Tyler, President. Taken from quarry near Farmer's Station, on the Chesapeake & Ohio Railroad, thirty-five miles beyond Mt. Sterling. Brought by Mr. W. W. Monroe."

A fine-grained sandstone of a handsome light-gray color on the recently exposed surfaces, showing a few minute spangles of mica. Adheres to the tongue. Stained light ochreous and brownish on the weathered surfaces. Showing no fossil remains, but **Spirophyton cauda-galli** (Hall) on one of its surfaces. This rock is used in the construction of the new courthouse at Lexington.

Specific gravity about 2.50. (This is somewhat difficult to take in lump, because it absorbs water.)

Composition (Air-dried).

	Per cent.
Sand and insoluble silicates	93.128
Iron carbonate	2.336
Lime carbonate	.578
Magnesia carbonate	.256
Alumina, phosphoric acid, etc.	1.188
Moisture and loss	2.514
Total	100.000

(Analysis by Dr. Robert Peter.)

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 252.

No. 1221.—Sandstone. Labeled "Knob Building Stone; mouth of Triplett creek, edge of Rowan County, Ky."

A fine-grained, gray sandstone. Adheres to the tongue. Powder nearly white. Specific gravity, 2.539.

Dried at 212°, its powder lost 0.40 per cent of moisture.

Composition, dried at 212° F.

	Per cent.
Sand and insoluble silicates	90.240
Alumina, and oxides of iron and manganese	3.965
Carbonate of lime	1.480
Magnesia	.932
Phosphoric acid	.117
Sulphuric acid	.269
Potash	.336
Soda	.089
Water, expelled at a red heat	2.900
Total	100.328

(Analysis by Dr. Robert Peter.)

May 1, 1908.

Laboratory No. G-2855.—Sandstone from the Rowan County Freestone Company, Farmers, Ky.

The sample consisted of several thin sawed strips of fine-grained, bluish-gray sandstone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	3.20
Silica, SiO_2	83.54
Alumina, Al_2O_3	9.86
Ferric oxid, Fe_2O_3	
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	1.01
Magnesium oxid, MgO	trace
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Potash, K_2O	1.32
Sodium oxid, Na_2O	.36
Total	99.29
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	0.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	0.00

(Analysis by J. S. McHargue.)

SIMPSON COUNTY

March 18, 1909.

Laboratory No. G-3041.—Limestone sent by the Franklin Concrete Company of Franklin, Simpson County, Ky. The sample consisted of a small cubical block of gray limestone containing rather large flat crystals of calcite. A very pure looking limestone.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.50
Silica, SiO_2	.90
Alumina, Al_2O_3	.19
Ferric oxid, Fe_2O_3	.11
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	54.60
Magnesium oxid, MgO	.83
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.13

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	97.50
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.74
Total calcium and magnesium carbonates	99.24

(Analysis by J. S. McHargue.)

March 18, 1909.

Laboratory No. G-3040.—"Limestone sent by the Franklin Cement Company of Franklin, Simpson County, Ky. The specimen consisted of a small cubical block of rather hard, grayish limestone."

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.24
Silica, SiO_2	2.68
Alumina, Al_2O_3	.38
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	47.60
Magnesium oxid, MgO	5.42
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	99.64
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	85.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	11.38
Total calcium and magnesium carbonates	96.38

(Analysis by J. S. McHargue.)

TRIGG COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., pages 262-3.

No. 1246.—Limestone. Labeled "Gray limestone used as a flux at Fulton Furnace. Found near the Furnace."

A gray, fossiliferous, fine-grained limestone; glimmering with small facets of calc. spar.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	88.180
Carbonate of magnesia	4.335
Alumina, and oxides of iron and manganese	.280
Phosphoric acid	trace
Sulphuric acid	.180

Potash	.251
Soda	.054
Silex and insoluble silicates	9.520
Total	102.800
Moisture expelled at a red heat	0.200
Percentage of pure lime	49.487
Total calcium and magnesium carbonates	92.515

(Analysis by Dr. Robert Peter.)

TRIMBLE COUNTY

From Kentucky Geological Survey Reports, Vol. 1, O. S., pages 358-9.

No. 164.—Limestone. Labeled "Marble, Corn Creek, on the Ohio River opposite to Marble Hill, the quarry of Conchitie Marble of Messrs. Wm. W. Dean & Co., in Jefferson County, Indiana, thirty miles above Louisville; supposed to be of the same kind. Quarry of Dr. Hopson."

This rock is of a warm, or drab-gray color, presenting a granular crystalline structure, containing many fragments of shells, especially of **Murchisonia bellicincta**; and very small portions of coral—probably **Chaetetes lycoperdon**—cemented by pure minute crystals of calcareous spar, which form the principal mass of the rock. Some of the fragments of fossils have a pink color; the cavities of some of the shells are filled with beautifully clear, colorless calcareous spar; in others the spar filling them is colored of a pinkish-brown, or flesh color by oxide or carbonate of iron; which appears occasionally in the stone in small spots and patches. On one of the specimens there is the fragment of a bi-valve shell, and in another two portions of Orthocerae. The weathered surfaces are remarkably even, and free from fissures, and indicate great durability.

Its composition was found to be as follows:

Specific gravity, 2.704.

	Per cent.
Carbonate of lime	96.03
Carbonate of magnesia	.74
Carbonate of iron	1.09
Phosphate of lime	1.19
Alumina	.16
Insoluble earthy matter (silica, etc.)	.66
Moisture	.06
Oxid of manganese	trace
Loss	.07
Total	100.00
Total calcium and magnesium carbonates	96.77

(Analysis by Dr. Robert Peter.)

UNION COUNTY

From Kentucky Geological Survey Reports, Vol. 4, O. S., page 210.

No. 1117.—Sandstone. "Used for Hearthstone at Suwannee Furnace, brought from Caseyville, Union County, Ky."

A friable, light-gray sandstone. Some yellowish ferruginous bands in parts. Under the lens, it appears made up of small clear rounded quartz grains, with no cement. Some few small black specks, and minute scales of mica in it, and some of the grains are discolored with oxid of iron.

Composition, dried at 212° F.

	Per cent.
Sand and insoluble silicates	98.080
Alumina, and oxides of iron and manganese	.440
Lime	trace
Magnesia	.466
Phosphoric acid	trace
Sulphuric acid	.066
Potash	.328
Soda	.255
Water, expelled at a red heat	.600
Total	100.235

(Analysis by Dr. Robert Peter.)

WARREN COUNTY

March 18, 1909.

Laboratory No. G-3030.—Limestone sent by the Franklin Concrete Company of Franklin, Simpson County, Ky., from their quarry near Woodburn, Warren County, Ky. The sample consisted of a small cubical block of gray limestone containing rather large, flat crystals of calcite. A very pure looking stone much softer than either of the other three specimens of stone sent with it. (See G-3027.)

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.50
Silica, SiO_2	.90
Alumina, Al_2O_3	.19
Ferric oxid, Fe_2O_3	.11
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	54.60
Magnesium oxid, MgO	.83
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.13

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	97.50
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	1.74
Total calcium and magnesium carbonates	99.24

(Analysis by J. S. McHargue.)

March 18, 1909.

Laboratory No. G-3027.—Limestone sent by the Franklin Concrete Company of Franklin, Simpson County, Ky., from their quarry near Woodburn, Warren County, Ky. The sample consisted of a small cubical block of gray looking limestone having a slight conchoidal fracture, very compact.

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	42.46
Silica, SiO_2	4.12
Alumina, Al_2O_3	.76
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	47.50
Magnesium oxid, MgO	4.93
Phosphorus pentoxid, P_2O_5	0.00
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.25
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	84.82
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	10.35
Total calcium and magnesium carbonates	95.17

(Analysis by J. S. McHargue.)

WAYNE COUNTY

August 19, 1910.

Laboratory No. G-3229.—"Sample of limestone from Wayne County, Ky., near Oz," sent by the Stearns Coal Company at Stearns, Ky., about May 25, 1910. The sample consisted of three rather large sized lumps and a few small sized lumps of gray limestone. A rather hard stone and breaks with an irregular fracture. Some small streaks of phosphate present. Some sand and clay adhering to the stones was washed before crushing.

Analysis of the air-dry sample.	Per cent.
Moisture	0.09
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.34
Silica, SiO_2	1.66
Alumina, Al_2O_3	.12
Ferric oxid, Fe_2O_3	.32
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	53.50
Magnesium oxid, MgO	1.17
Phosphorus pentoxid, P_2O_5	trace
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	trace
Total	100.20
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	95.53
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	2.46
Total calcium and magnesium carbonates	97.99

(Analysis by J. S. McHargue.)

WOODFORD COUNTY

November 8, 1911.

Laboratory No. G-3445.—"Glenn Creek. A short distance west of the Old Crow Distillery a road stars off southward up the hill. Lower part of the Paris bed, from 9-25 ft. below the Strophomena Vicina horizon. 3½ lbs. of light-gray crystalline limestone. Collected by Foerste, 1911."

Analysis of the air-dry sample.	Per cent.
Moisture	0.00
Ignition (carbon dioxid, organic matter, combined water, etc.)	43.26
Silica, SiO_2	1.00
Alumina, Al_2O_3	0.00
Ferric oxid, Fe_2O_3	.48
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	53.93
Magnesium oxid, MgO	.96
Phosphorus pentoxid, P_2O_5	.42
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	100.05

Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	96.30
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	2.00
Total calcium and magnesium carbonates	98.30

(Analysis by J. S. McHargue.)

October 29, 1911.

Laboratory No. G-3426.—"From railroad cut at Versailles, Ky., on the railroad from Versailles to Frankfort, Ky. Here the railroad passes by means of a concrete bridge under the Frankfort pike. Eight-foot section, from 19-27 ft. below the base of the arch at the cement bridge. Gray limestone. Collected by A. F. Foerste."

Analysis of the air-dry sample.	Per cent.
Moisture	0.06
Ignition (carbon dioxid, organic matter, combined water, etc.)	40.32
Silica, SiO_2	3.96
Alumina, Al_2O_3	.19
Ferric oxid, Fe_2O_3	.64
Ferrous oxid, FeO	0.00
Calcium oxid, CaO	49.84
Magnesium oxid, MgO	2.81
Phosphorus pentoxid, P_2O_5	1.40
Sulfur trioxid, SO_3	0.00
Titanium dioxid, TiO_2	0.00
Total	99.22
Calcium carbonate, $CaCO_3$, equivalent to the calcium oxid	89.00
Magnesium carbonate, $MgCO_3$, equivalent to the magnesium oxid	5.90
Total calcium and magnesium carbonates	94.90

(Analysis by J. S. McHargue.)

Kentucky Geological Survey Reports, Vol. 2, O. S., page 280.

No. 548.—Limestone. Labeled "Hill at Sryock's ferry, Woodford County, Ky. (Birdseye Limestone of the Lower Silurian Formation.)"

A compact, very fine grained rock, with casts of fucoid stems (?) passing perpendicularly through it, which are filled with pure calcareous spar; of a handsome yellowish-gray color, powder white.

Specific gravity, 2.705.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	94.75*
Carbonate of magnesia	1.96
Alumina, and oxid of iron, etc.	.63
Phosphoric acid	trace
Sulphuric acid	.30
Potash	.23
Soda	.32
Silica and insoluble silicates	2.18
Total	100.37

The air-dried rock lost 0.20 per cent of moisture at 212° F.

*Equivalent to 53.17% of lime.

Total calcium and magnesium carbonates, 96.71.
(Analysis by Dr. Robert Peter.)
From Kentucky Geological Survey Reports, Vol. 3, O. S., page 409.

No. 776.—Limestone. Labeled "Lowest rock in the bluff at Shryock's ferry; Kentucky River; Versailles road, Woodford County, Kentucky. Lower Silurian formation."

A grayish drab-colored, fine-granular limestone; homogeneous in structure; with no appearance of fossils in the specimen analyzed. Under the lens appearing to be made up of pretty pure, fine, crystalline grains. Powder yellowish-white.

Specific gravity, 2.655.

Dried at 212° F., the powdered rock lost 0.40 per cent of moisture.

Composition, dried at 212° F.

	Per cent.
Carbonate of lime	59.86*
Carbonate of magnesia	36.64†
Alumina, oxides of iron and manganese, and phosphates	.98
Sulphuric acid	.16
Potash	.40
Soda	.08
Silex and insoluble silicates	2.48
Total	100.60
Total calcium and magnesium carbonates	96.50

A pretty pure magnesian limestone, which promises to be a durable building material; resembles, in composition, the building stone from Grimes' and the neighboring quarries in Fayette County, on the Kentucky river.

*Equivalent to 33.59% of lime.
†Equivalent to 17.44% of magnesia.

(Analysis by Dr. Robert Peter.)

CHAPTER XII.

RESUME AND VOLUME OF PRODUCTION

The Commonwealth of Kentucky has between 600 and 700 quarries, most of which have been active during the past five years. Some of the quarries listed were active many years ago and are now idle, not because the stone was exhausted, but for various other reasons. Some quarries are opened for road work, and as soon as the permanent road in the immediate neighborhood has been constructed, the quarry becomes inactive, to reduce the cost of haulage to a minimum, and a new and more accessible quarry is opened. It therefore follows that any list of quarries that may be compiled will be subject to continuous changes, for new quarries are being opened every year. The quarry prospects that have been visited by, or cited to, the author exceed one hundred.

It must not be expected that all the quarries listed as good road stone have passed the tests required by the State testing laboratory at Lexington under the direction of Prof. D. V. Terrell. Some of them may never have been examined in the laboratory. The conclusions are, therefore, drawn: (1) From reports from the laboratory at Lexington: (2) From reports of officials of the Good Roads Department: (3) From reports of county road engineers: (4) From reports of county judges: (5) From examination of the wear of the stone on roads where it has been used: and (6) From the toughness, compactness, angular fracture, and the interlocking of the grains and crystals in the rock, as seen at the quarry.

The better building stones of the State naturally group themselves into districts, in which the building stones of each district have certain characteristics in common.

(1) Bowling Green district including the counties adjacent to Warren County wherever the oolitic limestone is thick bedded.

(2) The Kentucky River district including all sections along the Kentucky River where erosion has been carried downward to the beds of the Oregon and Tyrone formations, known respectively as the Kentucky River Marble and Kentucky Marble.

(3) The Louisville district, where thick bedded limestones are extensively quarried.

(4) The Central Bluegrass district, exclusive of the Oregon and Tyrone formations.

(5) The Rowan County district, which has furnished such a large supply of sandstone for constructional work.

(6) The Rockcastle County district with sandstones of younger age than those in Rowan County.

(7) The Big Sandy district, where there are several sandstones that constitute good building stone.

Aside from these districts, there are several isolated areas where good building stone for local use has been quarried.

The rocks that may be classified as marbles either commercially or mineralogically have been found in more than 25 counties in terranes of the Ordovician and Mississippian systems. The samples that have been polished and are now on exhibition in the museum of the Kentucky Geological Survey testify to the possibility of a large marble industry within the State.

The Mexican onyx, or onyx marble, of Barren, Edmonson, Hart and Metcalfe counties should not be overlooked as a commercial possibility.

The value of the products quarried and consumed within the State in the numerous uses of stone is very large, but the actual figures would be almost impossible to compile. The United States Geological Survey, under the direction of M. R. Campbell, has compiled the following important data concerning the output of stone from Kentucky as given on pp. 328-332.

Mr. G. B. Scott of the Louisville and Nashville Railroad has kindly submitted the following list of limestone quarries and manufacturers of ballast, building stone and agricultural limestone located on the Louisville and Nashville Railroad within the State of Kentucky:

Station	Name	Postoffice
Avoca	C. W. Bradshaw, Supt. L. & N. R. R.	Louisville
Benson	L. & N. R. R.	Louisville
Bowling Green	Bowling Green White Stone Co.	Bowling Green
Bowling Green	Kissler & Rigelwood	Bowling Green
Dudley	Clark Co. Construc. Co.	Winchester
Elkton	Cartwright & Brannum	Elkton

Station	Name	Postoffice
Glasgow	Harris Lime Stone Co.	Glasgow
Glasgow	A. L. Harris	Glasgow
Glasgow	Dickinson Bros.	Glasgow
Hopkinsville	Hopkinsville Stone Co.	Hopkinsville
Hopkinsville	W. S. Davidson	Hopkinsville
Hopkinsville	Planters Hardware Co.	Hopkinsville
Lexington	City Work House	Lexington
Memphis Junct'n	Bowling Green Whitehouse Quarry of Kentucky	Nashville, Tenn.
Trent	Price Stone & Lime Co.	Middlesboro
Mt. Vernon	W. J. Sparks	Mt. Vernon
Mt. Vernon	Fred Kreuger	Mt. Vernon
Russellville	Davis Co. Rock Quarry Co.	Russellville
Spark Quarry	W. J. Sparks	Mt. Vernon
Upton	Brown-Goodin Co.	Upton
Vileys	Home Construction Co.	Lexington
Winchester	Clark Co. Construc. Co.	Winchester

PRODUCTION OF STONE IN KENTUCKY

By A. T. Coons

The figures given below showing the statistics of stone production in Kentucky for a series of years are compiled from the annual reports of Mineral Resources of the United States published by the United States Geological Survey.

The stone production of this state did not assume proportions of any considerable magnitude until about 1900 when the crushed stone industry through an impetus of road building began to increase throughout the entire country. According to the Tenth Census Report there were four limestone quarries in operation in Kentucky in 1850-1858 and four more opened between 1860 and 1870, but none of these was in the famous Bowling Green tract, where the first quarry of importance was opened in 1872 by the Belknap-Dunnsville Stone Company. In 1880 this stone had become sufficiently popular to be shipped as far east as New York. In 1890 there were sixty-five quarries in operation in the State as reported by the Eleventh Census, of which fifty-four were limestone and eleven sandstone. In 1916, at the time the crushed stone industry was at its peak for this State, there were one hundred and nineteen quarries in operation. In 1921 eighty-one quarries reported production of stone. The figures presented below are chiefly for sandstone and limestone. From 1907 to 1915, a quantity of marble (onyx) was produced annually at Cave City, Barren County, and the output of this quarry is included with the totals for those years.

Limestone

The oolitic limestone quarried near Bowling Green, Warren County, is well known to the building stone trade. Although the first important quarry was opened in 1872, stone was first quarried here in a primitive manner in 1833, according to Wm. C. Day.*

Besides local and State markets this stone has been shipped to all the large eastern cities for building work and also to many southern and central cities and towns.

*Day, Wm. C., Min. Resources of the United States, U. S. G. S. Dept. of Interior. 1889-1890, p. 396.

It is chiefly sold for building work, but its light color and adaptability to carving makes it popular for ornamental and monumental work.

Building Stone

The stone at present quarried in Kentucky finds its greatest market in the form of crushed stone, but there are three building stone districts of considerable importance and the statistics of these districts are given for a series of years.

Sandstone

Sandstone is quarried at Wildie (Langford), Rockcastle County, by the Kentucky Freestone Company, for trimmings, sills, coping and small parts for buildings, and in Rowan County, the Rowan County Freestone Company, and the Bluegrass Quarries Company at Farmers, and the Kentucky Bluestone Company at Bluestone are the active producers. A large part of this sandstone is sold as sawed stone, but it is well adapted to cut stone, and while the principal market is in Kentucky, it is largely used in Ohio—especially Cincinnati—and has been shipped to Canada, New York, North Carolina, Texas, West Virginia, and other States. The stone is very fine grained and can be rubbed to a very good finish, but not polished. In this form it finds use in interior work especially for mantels. It is also sold for curbing, flagging, riprap and crushed stone. In the following table the figures for the two counties are combined in order to conceal the production in Rockcastle County.

Production of Stone in Kentucky, 1890-1921, Inclusive.

Year	Number of Plants	Approximate Short Tons	Value
1890	65	....	$421,254
1891	....	....	330,000
1892	....	....	340,000
1893	....	....	221,000
1894	....	....	123,022
1895	....	....	142,022
1896	....	....	129,295
1897	....	....	74,232
1898	....	....	145,612

Year	Number of Plants	Approximate Short Tons	Value
1899	....	....	286,171
1900	....	....	226,037
1901	....	....	295,536
1902	79	....	706,324
1903	....	....	789,344
1904	....	....	786,039
1905	....	....	1,025,044
1906	....	....	920,531
1907	....	....	1,022,450
1908	....	....	893,447
1909	90	....	1,000,709
1910	....	....	1,073,588
1911	....	....	1,627,609
1912	100	....	1,282,148
1913	92	....	1,150,205
1914	94	....	1,257,722
1915	98	....	1,071,052
1916	119	2,190,600	1,429,838
1917	90	1,582,000	1,118,434
1918	64	1,017,000	970,494
1919	74	1,215,330	1,447,352
1920	82	1,422,530	1,756,176
1921	81	1,573,750	1,877,487

Limestone Produced in Warren County, Ky., 1909-1921, Inclusive.

YEAR	Building and Monumental Stone (rough and dressed)		Other*		Total	
	Cubic Feet	Value	Short Tons	Value	Approximate Short Tons	Value
1909......	277,600	$123,925	67,000	$55,717	90,000	$179,642
1910......	294,700	113,491	110,700	53,116	135,000	166,607
1911......	237,510	122,381	58,000	26,171	77,000	148,552
1912......	263,020	152,412	39,000	19,453	61,000	171,865
1913......	206,490	110,638	39,000	22,521	56,000	133,159
1914......	185,320	96,335	39,000	22,344	54,000	118,679
1915......	185,750	88,117	18,000	8,639	33,000	96,756
1916......	256,710	119,700	16,000	16,493	37,000	136,193
1917......	201,580	107,279	22,540	20,240	39,000	127,519
1918......	88,580	58,732	2,470	2,684	9,800	61,416
1919......	108,320	100,817	7,540	10,732	16,500	111,549
1920......	98,700	123,010	7,480	12,420	15,600	135,430
1921......	128,000	170,540	6,230	5,840	16,800	176,380

*Other includes riprap, rubble, crushed stone, curbing, flagging, and fluxing stone.

Limestone Quarried in Kentucky, 1890-1921, By Uses.

YEAR	Building Stone (rough and dressed)		Riprap and Rubble		Concrete and Road Metal		Railroad Ballast		Flux		Agriculture		Other		Total	
	Cubic Feet	Value	Short Tons	Value	Short Tons	Value	Short Tons	Value	Long Tons	Value	Short Tons	Value	Short Tons	Value	Approximate Short Tons	Value
1890																$303,314
1891																250,000
1892																275,000
1893																203,000
1894		$96,119				*										96,119
1895		113,418				*				$3,604						117,022
1896		112,877				*				16,418						129,295
1897		27,943				*				6,289						34,232
1898		20,040		$591		**$42,185				10,271						73,087
1899		104,094		7,510		**44,845		***		6,248				$3,492		166,189
1900		121,623		12,500		**115,730		***		17,728				2,278		169,859
1901		59,125		5,500		69,793		$29,622		6,998				15,939		187,277
1902		124,467		22,500		151,185		176,032	36,350	15,487				88,183		577,854
1903		172,774		15,240		185,830		264,490	33,840	16,478				40,790		695,602
1904		134,781		18,184		217,755		280,489	18,070	9,420				31,788		692,417
1905		172,085		11,262	389,000	267,959	600,000	250,115	20,500	7,733				35,211		744,465
1906		209,839		29,217	910,650	273,204	563,500	242,737	23,990	15,170				25,241		795,408
1907		178,231		11,197	489,540	344,456	691,410	292,714	31,750	14,489				50,413		891,500
1908		121,288		27,976	525,950	386,059	525,060	235,802	21,950	11,283				27,682		810,090
1909		194,628		26,677	472,540	320,775	690,260	291,266	18,920	10,804				59,724		903,874
1910		166,376		37,754	708,190	399,213	724,130	317,221	16,850	9,627				48,618		978,809
1911		176,053		48,263	777,890	512,472	784,020	349,714	11,090	6,423				31,425		1,124,170
1912		188,201		45,697	670,330	404,947	1,024,540	473,023	14,530	9,670				38,610		1,160,148
1913		144,903		77,555	664,630	388,355	995,910	422,864	19,120	12,368		$10,582		12,407		1,069,034
1914		120,609		25,781	650,040	379,814	1,472,250	615,621	33,850	21,287		23,468		9,466		1,196,046
1915		113,507		37,008	741,630	457,886	769,890	327,578	29,970	19,259		31,303		6,847		993,388
1916	300,000	146,391	45,600	36,525	1,053,910	691,031	832,740	355,564	69,450	41,807	34,650	35,477	9,000	8,907	2,078,000	1,315,702
1917	250,000	112,267	38,080	32,161	663,550	462,424	701,440	338,996	54,920	44,826	25,720	22,362	9,000	9,281	1,520,000	1,022,317
1918	137,230	60,520	35,120	36,655	393,820	429,144	527,450	371,085	7,920	7,019	12,960	26,603	1,650	1,641	990,000	932,667
1919	202,340	114,424	28,220	26,103	386,870	579,713	728,400	553,871	15,650	18,513	31,470	59,147	2,430	5,847	1,200,610	1,357,618
1920	138,300	127,060	27,420	35,645	582,060	764,519	699,180	615,462	44,250	51,374	24,030	38,715	1,010	3,010	1,395,000	1,635,785
1921	145,000	173,370	5,640	7,570	790,720	988,753	695,320	552,404	****	****	13,070	18,048	7,180	15,360	1,523,890	1,755,505

*Included under building.
**Includes paving and railroad ballast.
***Included under concrete and road material.
****Included under other.

Sandstone Produced in Rockcastle and Rowan Counties, Ky., 1916-1921.

YEAR	Building Stone (rough and dressed)		Other		Total	
	Cubic Feet	Value	Short Tons	Value	Approximate Short Tons	Value
1916	120,000	$64,016	10,000	$5,644	19,800	$69,660
1917	115,000	53,276	10,240	3,015	19,700	56,291
1918	51,440	20,918	4,570	5,409	8,800	26,327
1919	121,000	84,312	300	61	10,200	84,373
1920	97,430	101,718	8,580	6,701	16,120	108,419
1921	110,530	89,744	28,690	18,738	37,760	108,482

Sandstone Produced in Kentucky, 1890-1921.

YEAR	Building Stone (rough and dressed)		Other		Total	
	Cubic Fete	Value	Approximate Short Tons	Value	Approximate Short Tons	Value
1890	....	....	....	....	....	$117,940
1891	....	....	....	....	....	80,000
1892	....	....	....	....	....	65,000
1893	....	....	....	....	....	18,000
1894	....	....	....	....	....	27,868
1895	....	....	....	....	....	25,000
1896	....	....	....	....	....	....
1897	....	....	....	....	....	40,000
1898	....	....	....	....	....	72,525
1899	....	$116,832	....	$3,150	....	119,982
1900	....	46,946	....	9,232	....	56,178
1901	....	100,569	....	7,690	....	108,259
1902	....	53,375	....	*75,095	....	128,470
1903	....	75,197	....	18,545	....	93,742
1904	....	56,373	....	37,249	....	93,622
1905	....	105,342	....	*175,237	....	280,579
1906	....	105,923	....	19,200	....	125,123
1907	....	75,380	....	23,070	....	98,450
1908	....	76,036	....	2,696	....	78,732
1909	....	89,442	....	1,393	....	90,835
1910	....	80,560	....	10,169	....	90,729
1911	....	91,461	....	5,978	....	97,439
1912	....	82,563	....	32,087	....	114,650
1913	....	72,157	....	9,014	....	81,171
1914	....	58,684	....	2,242	....	60,926
1915	....	59,984	....	10,180	....	70,164
1916	121,000	65,766	**103,640	**48,370	112,600	114,136
1917	115,000	53,276	52,500	42,841	62,000	96,117
1918	51,440	20,918	22,760	16,909	27,000	37,827
1919	121,000	84,312	4,800	5,422	14,720	89,734
1920	97,430	101,718	19,300	18,673	27,530	120,391
1921	124,040	92,244	39,690	29,738	49,860	121,982

*Chiefly crushed stone.
**Chiefly riprap.

CHAPTER XIII

BIBLIOGRAPHY OF BUILDING STONES

The bibliography submitted herewith is believed to be fairly complete for limestones, dolomites and marbles. This is essential because these types of building stone represent the most prominent constructional stone in Kentucky. The bibliography is not complete for granite and slate, but it includes many of the more important works relating to the granite and slate industry.

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